JOURNAL

OF THE

BATH AND WEST AND SOUTHERN COUNTIES SOCIETY

FOR THE

ENCOURAGEMENT OF

AGRICULTURE, ARTS, MANUFACTURES AND COMMERCE.

ESTABLISHED 1777.

FIFTH SERIES.

VOL. XI.

1916–1917.

WORK AND LEARN.

LONDON:

EDWARD STANFORD, LD., 12 TO 14, LONG ACRE, W.C. 2.

1917.

Price to Non-Members, Six Shillings.

" He that goes about to forward agricultural improvement must begin by finding out the true reason of what is called routine, or 'the custom of the country.' It sometimes happens that these reasons are only accidental, and then you may dismiss them fearlessly; but often it turns out that every-day practice rests on a solid foundation of facts; and then if you make an onslaught on local prejudices, they will be sure to beat you."

" The true course for the agricultural improver is, to take one step at a time to gain a clear insight into facts by experience, not to try to go too fast, and to trust to the work of time."

" If practice which sets up to do without theory is contemptible, theory without practice is foolhardy and perfectly useless."—*From the Rural Economy of England, Scotland and Ireland*, by LEONCE DE LAVERGNE.

Journal communications should be addressed to the Editor,
3, Pierrepont Street, Bath,

CONTENTS.

Volume XI.—Fifth Series. 1916-1917.

Original Articles and Reports.

THE NOTE BOOK.

THE FARMER'S LIBRARY.

APPENDIX.

PRIVILIGES, LAWS, OFFICERS, &c.

FINANCE.

ILLUSTRATIONS.

THE LATE GEORGE LIPPIATT GIBBONS.

JOURNAL

OF THE

BATH AND WEST AND SOUTHERN COUNTIES SOCIETY.

Original Articles and Reports.

In Memoriam.

I.—GEORGE LIPPIATT GIBBONS.

By Thos. F. Plowman, Secretary and Editor.

Not only the Bath and West Society but Agriculture generally was rendered distinctly poorer by the death on the 14th of August last of George Lippiatt Gibbons. By his force of character, strength of purpose, abounding energy and unique experience, he was enabled during a long and active life to render inestimable service to Agriculture and especially to the dairy side of it. By those engaged in the latter industry, he was regarded as the very fountain of knowledge, as the very chief of experts.

A thorough-bred Somerset man, he first saw the light at Church farm, Clutton, on January 23rd, 1832, and, having learnt the business of farming under his father, who died in 1875, he entered in 1859 upon the occupation of Tunley Farm, near Bath, where he lived to the end. While with his father, he started a corn and seed business on his own account and further developed it on going to Tunley, visiting Mark Lane every Monday and other leading markets on following days of the week. His tenancy, begun under the late Mr. J. Jarrett, of Camerton Court, was continued with the latter's successors and lasted during the whole of his long life. In 1859, Mr. Gibbons took unto himself a wife in the person of a daughter of the late

Mr. Joseph Harding, of Marksbury. The latter had a reputation far and wide, not only as a cheese-maker but also as a skilled instructor in the art, and he materially aided in extending a knowledge of the Cheddar Cheese system in Scotland. The marriage was a distinctly happy one, and in the object of his choice Mr. Gibbons found a devoted and most efficient help-mate. Her upbringing brought with it a knowledge and experience which proved of inestimable value, and her husband's many triumphs as a cheese-maker were largely due to her.

Mr. Gibbons's capacity for public work was discovered soon after he had entered upon the position of an occupier, and the readiness with which he responded to the many calls made upon him, and the zeal and earnestness with which he discharged the duties pertaining to them, testified to his strong desire to fulfil even more than could be expected of him in the service of his fellow-men. In 1860 he was elected a member of the Clutton Board of Guardians, on which body he served for the long period of forty-six years, acting as Vice-Chairman for twenty-four years of the time. The confidence he inspired may be judged from the number of offices with which he was entrusted. He was for many years Chairman of the Union Assessment Committee; Vice-Chairman of the Clutton Old Highway Board and of the Rural Sanitary Authority; the first Chairman of the Rural District Council of Clutton, acting as such until his resignation in 1906; and the first Chairman of the Clutton Old Age Pensions Committee, continuing in that capacity until failing health compelled him to resign in 1913. That he regarded these responsibilities in no perfunctory spirit is testified by the Clerk to the Clutton Union, who wrote me as follows:—"Mr. Gibbons was always a most regular attendant on every public body with which he was connected and during his long experience he acquired a unique knowledge of various kinds of public work. There was certainly no man in the whole area of the Clutton Union who ever gave so much time to local public service."

On the establishment of the Somerset County Council in 1894, he was one of the first Aldermen elected, receiving, with another member, the highest number of votes then recorded. He was from time to time re-elected to the position, which he held until his death.

Mr. Gibbons was a man of strong religious convictions, which he never shrank from expressing. He was staunchly Protestant and possessed a remarkable acquaintance with the Bible, as shown by the readiness with which he could make an apposite quotation from it at a moment's notice. Notwithstanding his multifarious

week-day labours, he found time to render good service to the Church, for he was Churchwarden of Camerton for 21 years and of Clutton for 10 years.

In 1879 he increased his home work by becoming the tenant of Church Farm, Clutton, under the Earl of Warwick, but when his youngest son, who had managed it for his father for some years previously, married in 1893, he gave the farm up to him.

Mr. Gibbons held his first public office directly connected with Agriculture in 1866, when he undertook and successfully carried out the duties of Hon. Secretary of "The Clutton, Bath and North Somerset Mutual Cattle Assurance Association," during one of the most terrible visitations—the outbreak of Foot and Mouth Disease—that has ever befallen Agriculture. In recognition of his services in this capacity he was presented with a silver inkstand and a silver cup.

Then, greatly aided by his skilled wife, who was a past-mistress in the art of cheese-making, he began to win prizes for Cheddar cheese at all the leading shows in this country, including the Royal, the Bath and West, the Liverpool and Manchester, the Yorkshire, and many others. But he carried the fame of his county still further afield, gaining honours at important exhibitions held at Paris, where he was awarded the gold medal, New York, Copenhagen, Amsterdam, and elsewhere.

Such a record might have been deemed all-sufficient by any ordinary man, but George Gibbons was no ordinary man, and Alexander-like he sought fresh worlds to conquer. This resulted in his being awarded, in 1875, the first prize of £50 offered by the Royal Agricultural Society of England for the best-managed Dairy Farm of not less than one hundred acres in extent in the County of Somerset. The Judges were three well-known agriculturists, viz.: Messrs. E. W. Little, T. P. Outhwaite, and J. Bowen Jones. The latter summed up his report upon the farm as follows:—"The general management of the farm is unexceptionable, and the returns, both of dairy produce, as shown by Mr. Little's Report, which follows, as well as those derived from other sources of the holding, are eminently satisfactory, and could only be obtained by a liberal and judicious management; and the Judges had much satisfaction in awarding Mr. Gibbons the first prize for dairy farms offered by the Society." Mr. Little, in his remarks upon the dairy management of the farm especially, said:—"Had the competition been larger, it is doubtful whether we should have seen any dairy farm in Somersetshire better managed than Mr. Gibbons's, both with regard to the land and to the process of cheese-making." He

further mentions that the process of cheese-making is carried on in the most perfect order under the superintendence of Mrs. Gibbons, assisted only by a girl at £9 per annum.

In 1878, Mr. Gibbons entered the lists again by competing for the prize offered by the Royal Agricultural Society of England for "the best managed Dairy or Stock Farm of not less than 200 acres in extent, where the cultivation and management are chiefly directed to the production of cheese or butter, or of animal food," and was awarded the second prize of £25. The judges (Messrs. T. Willis, jun., T. F. Jackson, and F. Beard), spoke in high terms of the farm-buildings especially, and Mr. Jackson, in his report on the system of cheese-making practised at the competitive farms, in allusion to Mrs. Gibbons as a cheese-maker, says that she "has good accommodation and the latest appliances, and these, combined with skill and careful management, enable her to produce an article worthy of exhibition anywhere. The dairy accommodation on this farm is superior to any that came under our notice."

In 1869 Mr. Gibbons joined the Bath and West Society, and it is in connection with his work for that Society that he will be more particularly remembered. In 1883 he was elected on the governing body, where his exceptional knowledge and ability were soon recognised. He was not long in making his influence felt, for, in a great measure through his persuasiveness, the Society, in 1885, when the Show was held at Brighton, offered prizes for cheese and also instituted a fully-equipped Working Dairy in the Show Yard. Only once before, viz., in 1881, had a dairy formed part of the Society's exhibition. The arrangements then, although supervised by Mr. R. Neville Grenville as the Steward, were in the hands of a private company, who most efficiently carried out their undertaking. The Brighton Dairy, worked entirely by the Society with Mr. Gibbons as Steward to superintend it, was on a more complete and comprehensive scale, whilst the educational side of the undertaking was much more fully developed. The best methods of making butter and clotted cream were practically demonstrated by experts and the latest dairy implements and appliances were shown at work, whilst various continental systems for the making of soft cheeses were described and illustrated. The success of this new development and the interest taken in it by the general public resulted in the establishment of the Working Dairy as a permanent feature of the Society's Show. In succeeding years, an additional attraction was provided in the shape of Butter-making and Milking Competitions, and these well fulfilled their purpose by the encouragement they offered to the acquisition of skill and

experience in dairying and by the opportunity they afforded of showing what constituted good work. The Society was enabled to embark upon these new departures because it had in Mr. Gibbons one who had both the knowledge of what was required and the ability and the willingness to bring it to bear.

The results of the work done in the Working Dairy were very encouraging, for satisfactory evidence was forthcoming that the effect of the lessons it was intended to inculcate was not lost upon the dairying industry generally. A desire was consequently expressed in several quarters for an extension of the Society's operations in this direction, it being felt that its organisation might be utilised in providing further facilities for those who were anxious for instruction. It only needed the impetus given by the recommendations, with respect to Agricultural and Dairy Schools, of a Parliamentary Commission—presided over by the late Sir R. H. Paget, a Vice-President of the Society · and the offer of a Government Grant-in-aid to induce the Society to go forward. A Special Committee, consisting of thirteen of the Society's most active workers interested in dairying, with the then President (the late Lord Clinton) at their head, was appointed by the Council with a view to their reporting how the Society could best further the recommendations of the Commission. To me, who was so intimately associated with the members of the Committee in the inception and carrying out of the scheme, it is a melancholy reflection that Sir C. T. D. Acland and myself are the sole survivors of that little band.

Nearly thirty years having elapsed since the Society took upon itself to supply a much-needed want, and as so very few of those who were a party to it are left, it seems worth while to take this opportunity, while dealing with the life of one to whom the movement owed so much, to narrate how the Society came to be regarded as a veritable pioneer in dairy education.

A consideration of all the circumstances induced the Committee referred to to conclude that the Society could best aid the objects in view by establishing migratory schools for the teaching of the best methods of butter-making in such districts as might desire them within the area over which the Society's operations extended. So they drew up a scheme which was approved by the Society's Council, who made a grant for its working. The plan proposed, which came into operation in the autumn of 1888, embodied a policy of mutual help, the Society joining hands with those outside it in an endeavour to assist the dairying industry of the country. It was deemed wise at the outset to confine the instruction to butter-making, reserving

cheese-making to be dealt with later on if events justified it. It was soon recognised that a disinterested effort was being made to lend a helping hand to an industry suffering from a plentiful lack of that tested and proved knowledge which, nowadays, is so essential to the carrying on of any occupation whatsoever. As soon as this was fully realised the success of the movement was assured, and the migratory Dairy School began to be called for in various directions. The main demand for it arose, however, when County Councils commenced allocating some of the funds at their disposal to the purposes of Technical Education in Agriculture. Then it was that the information and experience which the Society, through its representatives, possessed were fully drawn upon by public bodies, and from many quarters far distant from its centre of operations, as well as from those nearer home, came the cry, "Come over and help us."

The Society gladly responded, either by itself equipping and conducting schools, or by rendering such help as enabled other bodies to do so. Representatives of the Privy Council and later on of the Board of Agriculture reported most favourably as to the quality of the teaching and the general work of the schools, and both bodies showed their appreciation by making monetary grants to the Society in aid of the objects aimed at.

This financial assistance, added to that contributed by the various localities visited, enabled the Society to open and conduct 169 schools in 16 different counties and these were attended by 3,084 students.

Mr. Gibbons threw himself heart and soul into this extension of the Society's operations, working with untiring energy to achieve that success for the movement which it never lacked from start to finish. The distances separating the various schools necessitated frequent travelling, for each locality had to be visited for the arrangement of preliminaries and several times during the progress of the school. I doubt if Mr. Gibbons was ever happier than when on such expeditions, and, as his companion on most of them, I can testify to his remarkable physical endurance, inasmuch as he never seemed to tire, however tedious the journey or however arduous the duties to be fulfilled in addition. I have often envied him his alertness at the end of a long day, sometimes running well into the night, spent in travelling to and from out-of-the-way places and in the work of organisation.

He was a great believer in Sulphate of Ammonia, not only as a fertiliser but especially as a personal pick-me-up. He carried a supply of it loose in his waistcoat pocket, and, when feeling tired and in want of a reviver, he took a pinch as though it were snuff, and always declared it did him "a power of good."

The Butter Schools were carried on for ten successive years and until the various County Councils for whom the Society had acted were in a position to undertake the work themselves.

The success of the Butter Schools induced the Society to provide a Cheese School for the County of Somerset, the County Council making a monetary grant for the purpose. The School, which was started in 1890, was held in one place for the whole of the cheese-making season, and the following year it moved on to another district of the county. Fifteen districts in Somerset and one in Dorset were thus visited, and 706 students received instruction. The price realised by the cheese made at the school afforded good evidence of the efficiency of the system pursued there, whilst the Inspectors of the Board of Agriculture, who reported upon the School, testified to its value as an educational medium. Mr. Gibbons supervised the practical work of the School, whilst attached to it was an experimental station, under the superintendence of Mr. F. J. Lloyd, F.C.S., the Society's expert, who conducted a series of researches with regard to cheese-making which yielded some valuable results. In a report presented to Parliament by the Board of Agriculture in which detailed particulars were given of the work of the Society, the latter is credited with having "been virtually the pioneer in the establishment of dairy classes." With reference to the Cheese School, it says, "The pupils were mostly of the farming class, and the results of instruction, so far as can be ascertained, are better produce and better prices. Some large cheese buyers in the neighbourhood have spoken highly of the value of these Cheese Schools in the way that they are improving the make of cheese in the district." The report also alluded to "the interesting results and observations" recorded in the Experimental Section of the Cheese School, and reproduced a considerable portion of Mr. Lloyd's Report which had appeared in the Society's *Journal*. The Board further showed its appreciation of the Schools by grants in aid. The School was continued by the Society until 1906, when it was taken over by the Somerset County Council, who, with the Society's experience as a guide, were then able to undertake this responsibility.

Since the establishment of the Butter and Cheese Schools in 1888 and up to the end of 1905, the Society, in conjunction with County Councils and other public bodies for whom it had acted, expended no less a sum than £31,940 in the promotion of technical instruction in dairying through the medium of these Schools. Even this amount by no means represents the total expenditure, for it does not include many local expenses, in connection with the travelling Butter Schools, undertaken by local bodies co-operating with the Society.

Mr. Gibbons was undoubtedly the pivot upon which everything turned in connection with the School, for his unique store of knowledge of all pertaining to the making of cheese was a most important factor in the success of the undertaking.

The Society also owed much to his efforts in securing additions to its ranks, for he was instrumental in largely augmenting the roll of membership. The number of recruits who gave a favourable response to his appeal was a strong testimony to his influence with agriculturists generally.

He was the only farmer appointed to act on the Departmental Committee, of which Sir Horace Plunkett was Chairman, charged by Parliament to report upon the question of water in butter. He was selected to give evidence before Parliamentary Commissions dealing with dairying and railway rates and was one of the Honorary Correspondents of the Board of Agriculture. He was a most ready and fluent speaker, preferring to trust to his voice—which served him well, being distinct and penetrating as well as pleasant to listen to—rather than to his pen for the promotion of the causes he had at heart. Nevertheless there stands to his credit in the Journal of the Royal Agricultural Society of England a good practical article upon a subject with which he was so fully acquainted, viz.: "The Practice of Cheddar Cheese Making," and four editions of this were published in a separate form. He also read a paper on "The Dairy Industry Past and Present" before the Bath Meeting in 1888 of the British Association and one, on "The Dairy Industry of Somerset," at the 1893 Meeting of the British Dairy Farmers' Asssociation. He was constantly being applied to by landowners and various public bodies to recommend them dairy-assistants, for no one knew better than he where to put his hand upon what was wanted in this connection, and he had the honour, which he greatly esteemed, of finding dairymaids for both the late Queen Victoria and King Edward VII. for their Windsor Dairy.

At the 1914 Annual General Meeting of Members of the Bath and West Society, held in the Showyard at Swansea, Mr. Gibbons was unanimously elected a Vice-President of the Society, "in recognition," as the Resolution proposing it stated, "of the valuable service he has rendered to the Society and to Agriculture generally, in connection with dairying especially."

The many responsibilities already referred to, coupled with the management of his own farm (on which he took pupils, both English and foreign) were insufficient to absorb his almost inexhaustible energies, for he readily responded to requests for his

services as a judge of anything and everything pertaining to dairying from all parts of the kingdom. Implements also came within his adjudicatory sphere, whilst he was one of the judges of farms for the Royal Agricultural Society in 1880. He was Napoleonic in his ideas, and it was no easy task to convince him—in fact you never did convince him—that there could ever be an insuperable obstacle to the realisation of anything upon which he was bent. His natural hopefulness, which represented an ever-trustful belief in possibilities—otherwise uncertainties—rendered it impossible for him to take failure into his reckoning, whilst it was equally difficult for him to conceive of any financial limitations when his heart was set upon what his brain had conceived. His sanguine temperament chafed under official restraints, but his good temper generally enabled a *modus vivendi* to be found. So we often agreed to differ, but it was with regard to methods rather than principles, and it never interfered with the continuity of our friendship. "Difficulties," he used to say, "were made to be overcome," and, if it were urged that something he had in his mind was "impossible," he was apt to think that every argument was met when he remarked that he had no such word as "impossible" in his dictionary. This probably goes far to account for the fact that, although he did not compass all his ends, he often succeeded where another would have failed. He worked upon broad lines, leaving detail to others, and he preferred to rely upon his own resourcefulness—which rarely failed him—for help at a pinch rather than upon anticipatory preparation, whilst a state of high-pressure seemed rather congenial to him than otherwise.

He made himself at home wherever he went, and his natural unaffected ease of manner helped him to hold his own in whatever company he found himself. His good-nature and his good-humour, combined with a well-stored mind and a remarkable knowledge of men and things, with a happy knack of effectively imparting what he knew, rendered him at all times very companionable. He was a good *raconteur* with a most retentive memory, which enabled him to hark back upon the past to the interest of his listeners. He was fond of recalling his visit to the Royal Agricultural Society's fourth show at Bristol in 1840 on land, now built over, near the Victoria Rooms, and he would draw instructive comparisons between the nature and dimensions of that exhibition and its successors in after-years. He attended the big dinner held on that occasion in the Show Yard when 1,700 sat down and there were seventeen toasts—a greater infliction than would be borne patiently nowadays. That he was an adept at promoting friendly dis-

course was testified to by the cheery conversational ripple which ever marked his place at the Council Mess. He could bring his unusually keen powers of observation to bear with all the more effect because he kept himself so well up to date with respect to the movements of his time, especially in connection with everything relating to the countryside. He had a shrewd and ready wit with which to drive a point home and a special aptitude for the bestowal of a pretty compliment—especially when it found its application in one of the opposite sex whose looks were on a par with the grace of the compliment. The story of how effectively he once brought his special gift to bear in the presence of royalty has oft been told, but I think it is entitled to mention here as it is so characteristic an instance of that tactful readiness of reply which so often sprang spontaneously from his lips. At the Bath and West Show at St. Albans in 1896, the Princess of Wales (now Queen Alexandra), who was being shown round the Working Dairy by Mr. Gibbons, observed with a smile, " the best butter, you know, comes from Denmark." " Pardon me, your Royal Highness," said the Steward, with a twinkle in his eye, " we think the best butter is made in England, but we have to go to Denmark for the best Princesses." The Prince of Wales (afterwards Edward VII.), overhearing this, joined in with " Ah, now you're buttering her ! "

His length of years and the retention, until within a comparatively short time of his death at the ripe age of 84, of his mental and physical powers go far to prove that hard work is not incompatible with prolonged life, however full and strenuous that life may be. By the many with whom he was associated in public work he will long be quoted as an example of how much usefulness a single life can compass and how well a man can serve his day and generation when he gives his mind to it.

It was only within the last few years of his life that any abating of strength or slackening of effort were observable. His last appearance in the Society's Working Dairy was at the Truro Meeting in 1913, after a discharge of the duties without intermission for nearly 30 years. Then, although he by no means entirely relinquished all his old pursuits, the necessity of restraining some of his activities was forced upon him and he had to recognise this. His excellent constitution served him well to the end, and happily spared him any long and painful illness. His strength gradually and imperceptibly ebbed away until in all peacefulness he was summoned home in the 85th year of his age.

Many friends and neighbours and representatives of the various public bodies with which he had been associated, including the

Bath and West Society, paid their last tribute of respect and regard when, the labourer's task being done, he was laid to his well-earned rest in Camerton Churchyard and 'neath the shadow of the church which he had served so well as its Warden.

At the first meeting of the Society's Council after this, the following Resolution was unanimously passed:- "That the Council desire to place on record their deep regret at the death of their friend and colleague, Mr. Geo. Gibbons, who for long had identified himself with the Society's work, and had rendered essential service as Senior Dairy Steward. Further, that the sincere sympathy of the Council be tendered to the members of his family in their bereavement."

The feeling then expressed was in accordance with that conveyed by the inscription, "In affectionate remembrance, from his old friends and colleagues of the Bath and West Society," attached to the bay-leaf chaplet laid on his grave on the Society's behalf.

I have endeavoured to place on record with some fulness the manner of man George Gibbons was, my justification for the doing of it being that I doubt if anyone, outside his own family, saw more of him than I did and under so many different circumstances. I was officially connected with the Society during the whole of his membership, and soon we were on terms of intimate friendship. We travelled many hundreds of miles in each other's company, with the opportunity this afforded for close intercourse, we stood together on many public platforms when our joint mission was to enlist recruits for the Dairy Schools, we exchanged many confidences, and it fell to me to help materialise and put into practise the developments of his active mind. Anyone who saw as much of him as I did would say that no abler or more zealous representative of the yeoman-farmers of England, to whom Agriculture owes so much, ever sat at any Council table.

A life so much out of the ordinary ruck seemed to call for something more than a simple obituary reference; hence this tribute, inadequate though it be, to my old friend's memory.

II.—AGRICULTURE AFTER THE WAR.

By A. T. Matthews.

INTRODUCTORY.

In dealing with this important subject I must endeavour to avoid even the appearance of setting up as a prophet. The future is hidden from us and the utmost we can do is to consider probabilities. Yet foresight is an admirable thing, invaluable in the world of commerce, and in agriculture it will often turn the scale between success and failure.

It is so even in ordinary times, but it becomes far more necessary in the tremendous upheaval through which we are passing, for there must be great changes for better or worse. It is time to prepare for those changes, and the first thing is to discover what they are likely to be, as this will be the main object of this article. By the time it reaches the public it may be that peace will be signed and an industrial crisis will be upon us, unique in its character and unprecedented in extent. In that case it may be read with less interest and serve a less useful purpose. Let us hope, for humanity's sake, that it may be so, provided that the peace be a just one and of a permanent character. There are people who tell us that the war will change everything, and that nothing will ever be the same again. That is a very sweeping assertion, but one that may probably prove largely true. Let us then do our best, so far as agriculture is concerned, to see that the changes shall be for the better. One of the most hopeful signs—if we may venture to judge by many public utterances—is the changed attitude of the powers that be towards the industry. This at least had made a small beginning before the war, otherwise we should not have had the Live Stock Improvement Scheme, but two years' experience of the pressure of a great war on our food resources has opened the eyes of politicians to the importance of home production as nothing else could have done, and the status of agriculture, as an industry has gone up many degrees. We may therefore conclude that it will at least receive fair play in the coming years, so far as legislation is concerned, and that will be an immense step forward.

In the days of extreme cheapness, which spelt ruin for so many British farmers, their interests were left to take care of themselves. The prevailing idea was that we could always depend on the world's surplus supplies for our food, and that so long as the nation continued to prosper commercially nothing else mattered. No wonder then that Germany should surpass us in food production, or that

the soil of Britain should pass out of cultivation more and more every year. The country was asleep, but there has come a rude awakening. The war came with the suddenness of an earthquake shock which found us unprepared. We were compelled to ask our little army to perform miracles, and we had no reserves of food for more than a very brief period. The strong measures adopted in the world's markets averted a panic, but the situation was so grave that it has taught us a lesson, which will not easily be forgotten, on the importance of its agriculture to any nation, and above all to an island nation whose necessary supplies from abroad are liable to even temporary interruption. To consider and suggest some of the means available for the application of that lesson is the object of the following pages.

WHEAT PRODUCTION.

Of all the products of the farm, wheat naturally takes the first place in any discussion on agricultural economics, not only because of its importance as the staple food of the people, but also on account of its prominence as a subject of controversy whenever fiscal questions are debated.

For over a century it has been, at more or less frequent intervals, the shuttle-cock of party politics, and nothing could well be more futile at the present juncture than to build up an argument on the future of wheat growing in this country in the existing unformed state of public opinion.

Politicians regard the subject as a hot coal which has burned their fingers in the past, and they will await developments in the party arena before attempting to handle it. Practically all are agreed that more wheat should be grown. That is a safe proposition, but the moment *inducements* are mentioned there is at once a dubious shaking of heads. In the autumn of 1914, farmers were implored to sow every possible acre, and they patriotically responded, but does anyone suppose that they will extend its cultivation after the war with the prospect of having to sell it at 25s. to 30s. per quarter? There is one thing, however, on which we may safely reckon. There must be some scheme formulated in the near future for the storage of sufficient wheat and flour in this country to maintain the population for many months, apart from current supplies, and much debate will probably arise on the best method of securing this national reserve. It may include the holding back of the British crop in stack by the payment of a certain sum on wheat so held, for such a plan would save the building of granaries, and, at the same

time, ensure the grain being kept in the best possible condition. Provided that the remuneration for holding stocks in this way for the public benefit were sufficiently high, there would be a distinct inducement to grow wheat, but this, like the other proposed remedies for the neglect of the crop, is entirely a question for future consideration.

The Departmental Committee on the Home Production of Food, whose report appeared in June, 1915, boldly recommended the guarantee of a minimum price and suggested that it might be placed at 45s. per quarter for a period of four years. Though rejected by the Government, as was to be expected, this plan still holds the field and appears to be enlisting considerable support in influential circles. Perhaps the most significant sign of the general trend of thought on this subject comes from Labour, as a quotation of its new and powerful organ, *The British Citizen and Empire Worker*, will show. In a recent issue we find these words :—" To illustrate this I will take the case of wheat. We will suppose that the United Kingdom cannot produce wheat at a reasonable profit, under normal conditions, at less than 40s. per quarter, such normal conditions including a standard wage to the farm labourer which will enable him to live in reasonable comfort and rear a healthy family. This, therefore, means that the farmer must expect to be sufficiently protected against dumped wheat from abroad to ensure his getting 40s. per quarter for his wheat."

Such a remark as this would certainly never have been printed by any Labour organ before the war, and that it should have been allowed to appear is a fair illustration of the change which the war has brought about in the views of the working classes on questions relating to the land, The ultimate decision will rest with them, and we have here a cogent warning to any writer who feels tempted to dogmatise on the future of wheat growing in this country.

LIVE STOCK PRODUCTION.

Turning from the highly debatable subject of wheat to that of meat, we find ourselves on far more solid ground, from which we can regard the future with confidence and hope. All the new farming countries can produce wheat, some of them of better quality than our own, but in the matter of cattle, sheep, and pigs, we bear the palm, and shall continue to do so while our climate remains unchanged and British farmers retain that skill and aptitude for breeding the best which has given them the premier place in live stock improvement.

Long before the war there were undoubted signs that the world's consumption was overtaking the production of meat. Markets were steadily rising, and trade experts were writing alarmist articles on the growing scarcity of cattle and sheep owing to consumption overtaking production. The rapid increase of population in the United States was compelling that country to cease exports and to become a competitor with Europe for the surplus supplies of the southern hemisphere, though not, as yet, to any serious extent. Britain's virtual monopoly of those supplies was being further threatened by a growing demand for cheap meat on the continent of Europe, while new areas of production in Brazil and South Africa were only in the infancy of their effort.

Such was the state of things when the war broke out and increased enormously the difficulties of the situation. The rise in freights alone was sufficient to drive up the prices, while the belligerent nations became eager buyers for their armies in the field, and at the same time in France and Germany a great wastage of stocks set in, the effects of which will be felt long after the return of peace.

Whatever the immediate effects of war may be on the markets while it lasts, they supply no argument in themselves as to what the prospects may be for future stock-raising in this or any other country. However severe they may be, they are of a temporary nature, and would gradually disappear under normal political conditions. Of far greater weight for the consideration of British farmers in laying their plans for the future are the great facts already referred to in connection with the world's supply and demand. The following is from an American newspaper, and its significance is all the greater because it refers not to America only but to the meat trade conditions of the whole world :—" While a late report of the Department of Agriculture announces a gradual expansion in cattle production in the United States in the last two years, there is no immediate prospect of a decline in the price of beef. Expansion of production is not yet keeping pace with growth of population. The condition is world-wide. In none of the principal meat-exporting countries—Argentina, Australia, Canada, Mexico, New Zealand, and Uruguay—is the number of cattle much more than holding its own, except in New Zealand, where the increase is not large and the relative importance of beef exports is small. The United States consumes more meat per head than any other country in the world, with the exception of Australia and New Zealand. We eat twice as much meat as the Germans do normally, while the normal consumption in Russia, Great Britain and France is less than that of Germany. As to cattle, we had on

January 1st, 1916, 61,441,000 on farms and ranges, and a human population of about 100,000,000. Compare this with Argentina, with 28,000,000 cattle in 1913, and a population of 7,200,000. Being large meat eaters we now import more beef than we export. Although the population has increased about 10,000,000 in the last decade, receipts of cattle in 1914 at the stockyards of Chicago, Kansas City, Omaha, Sioux City, St. Louis, St. Paul, and St. Joseph, were fewer than in 1904 by more than 1,000,000."

At the present rate of production on the one hand and consumption on the other, it appears certain that for many years to come the United States will require more and more meat from those countries which are now supplying us, and it is still more obvious that competition nearer home will be a still more serious factor. True that good prices will greatly encourage new enterprises, the beginnings of which are already visible, but five years, at the very least, must elapse before Brazil and South Africa can do enough materially to alter the balance of supply and demand, and that is quite far enough for us to attempt to peer into the future. For that time, at least, the prosperity of British agriculture will largely depend on its production of meat and milk, and it will be interesting to enquire whether that prospect is meeting with due recognition from those most directly concerned.

There is the strongest evidence that our farmers, as a class, are becoming fully awake to the general position as regards live stock, for they are showing in the most practical manner what they consider the probabilities of the future to be. There never was a time when the agricultural returns were awaited with so much anxiety as that felt by many during the summer of 1916. The average value of prime Shorthorns had risen in two years from 9s. to 15s. 10d. per 14lb. stone, and the best fat tegs from 9d. to 14d. per lb., representing, roughly, an advance of £16 on a bullock, and £1 5s. 0d. on a sheep of moderate weight. Realizing what such enhanced prices must mean to the average farmer it was greatly feared that the temptation to secure them would prove so great that there would be a serious reduction in the number of breeding cattle and sheep. Instead of that, we find that the last returns showed a record number of cattle and an increase of 428,540 sheep. Comparing the numbers collected in 1914, just before the war, with those now possessed by England and Wales, we find an increase in the two years of 337,836 cattle and 691,426 sheep.

To quote the *Live Stock Journal* on these figures:—"They are more than satisfactory—they are splendid."

In the present writer's view we have had no such proof of the

revival of British agriculture for many years. It points, indeed, to a stronger financial position, but, better still, it shows a confidence in the future which has long been lacking and without which there can be no enterprise.

The decrease of 313,541 pigs is the only drawback, and to account for this is very difficult in view of the fact that bacon pigs have about doubled in value in the two years. The increase of swine fever and the high cost of feeding-stuffs seem scarcely sufficient to explain it. The breeding and feeding of pigs have always fluctuated in this country and it is highly probable that the next returns may show a large increase.

On the whole, then, the indications are highly favourable to a great advance in the production of meat after the war.

DAIRY FARMING.

The war has given rise to great difficulties for the milk producers. The cost price of the cows has been very high and is still advancing; all concentrated foods are very dear and the scarcity of labour in many districts has been so serious that it has been almost impossible to obtain efficient milkers. These drawbacks, however, can scarcely be permanent, and the return of peace should restore the industry to its old position as one of the safest branches of farming. It has the immense advantage of a practical monopoly, and it produces an indispensable commodity, the demand for which is always steadily increasing. The opinion is often expressed that the price to the consumer will be very long in getting back to its old level of 4d. per quart, but there seems little to warrant that view. It is not high prices so much as cheaper production which will maintain and even increase the profits of dairy farming, and it is cheaper production that is certainly coming. That very desirable object will not be obtained by lower rents, lower wages, or cheaper feeding stuffs, but by raising the average yield of cows. An excellent beginning has been made in that direction by using a small portion of the Development Fund for the establishment of local milk-recording societies. This movement is certain to spread rapidly after the war, because its advantages are so obviously discernible by even the meanest capacity. The very first step towards improvement of the total yield of a given number of cows must be to find what quantity each one is giving annually. To this end periodic weighings will roughly answer the purpose, but it is far better to do the thing thoroughly and record every cow's yield at every milking. The

writer did this for many years with a large herd, and found the little extra trouble was well repaid. That system established, the farmer can proceed to get rid of every cow shown to be yielding less than a paying quantity and substitute better ones. That, however, is but the A, B, C of the business, for it is only by skilful breeding that any real and permanent advance can be made. In that matter, happily, we have rapidly progressed in the last few years so that breeders for the dairy have every facility, the way having been paved for them by the skill and enterprise of men, amongst whom the late Mr. George Taylor was a shining light. It has been clearly demonstrated that by the use of sires from heavy milking strains it is easy to produce cows yielding from 800 to 1,000 gallons yearly, and in exceptional cases considerably more. We may venture to estimate a possible increase of at least 200 gallons per annum over the old average yield, and there is every reason to believe that it is only a question of time before it will be done.

The great advantage of official records made through a society over private ones will be the additional market value of cows and their heifer calves given by the society's certificate, and enough has already been done in this way to show that such value is real and tangible, many instances having already been quoted in the *Board of Agriculture Journal* of sales at substantially increased prices on the strength of these certificates.

The art of cheese-making is also making excellent progress in this country and has evidently a future before it, so that the cheese factory will present the milk producer with an alternative market and thereby materially strengthen his position.

HORSE BREEDING.

In touching on the subject of horse-breeding as an industry of the future, we find ourselves on tender ground. The advent of the motor, and the wonderful progress it has made within a very few years has implanted the idea in some minds that the horse is doomed, if not to extinction, to a very limited sphere of action. Actual events, however, by no means favour such a gloomy view of the future of the noblest of all the dumb animals. True it has been nearly displaced in our towns for purposes of locomotion, and a large number of tradesmen and manufacturers have abandoned its use for haulage, whilst there has been a steady growth of motor traction on farms. But, in spite of this, the demand for good heavy horses has shown no signs of collapse and prices have been well maintained.

It is reasonable to suppose that at the close of the war a large number of horses and motor lorries will be thrown on the market, thus causing a slump in prices, which may be only temporary, for there must certainly be a huge demand in European countries to make good the wastage of horse-power. There is also a great probability of an improved demand from the colonies. "Threatened men live long," as do some threatened industries, and that of horse-breeding will, in all likelihood, continue to hold a high place on the farm for an indefinite period.

SUGAR BEET.

The subject of sugar production in the United Kingdom has been discussed for many years, and the idea has never lacked a considerable amount of support. Long ago a serious attempt was made in Suffolk to establish the industry, which was only frustrated by adverse fiscal measures adopted in foreign countries. That was a bad precedent, and a long interval took place before any further practical effort was forthcoming. The idea, however, survived, and later on important trials, carried out by Lord Denbigh and others, demonstrated the vital fact that sugar beet could be successfully cultivated in this country without difficulty, and not only so, but that the sugar content of British beetroot was second to none. This cleared the ground so far as soil and climate were concerned, but there still remained the formidable barriers of possible taxation, huge foreign competition, and the difficulty of raising capital for an enterprise which had hitherto met with so little encouragement.

In the year 1912, however, with material assistance from Holland, a company was floated, and the Cantley factory was built. In the following year work was actually started and the farmers of Norfolk made their acquaintance with the new crop. Of the financial success or management of the company the present writer is not in a position to speak, but enough has transpired to prove that British grown sugar might be made a gigantic success and that farmers could grow the roots at a good profit.

So much for the chequered history of the movement up to the present date, when we have reached the parting of the ways and it is for the country to choose which it will take. The war showed us, as by a lightning flash, what its sugar supply meant to the country, and the whole subject has been forced upon it for serious consideration and practical treatment.

It would not be politic to state here any particulars of what is being done, but it may be said that very powerful agencies are at

work clearing the ground and laying the foundations of a structure, the influence of which will pervade the whole country. In other words, the next step towards the establishment of a sugar industry in these islands will be of a national character, and the scheme will be drawn on safe commercial lines calculated to avoid the dangers and difficulties which have beset all previous efforts.

From the national point of view, the foundation of a vast new industry should have the happiest results. It will provide employment for many thousands of workers in the building of factories and the manufacture of machinery, and, later, in the actual working of the factories, besides the extra work on the land entailed by the growth of the beet. It will also retain in this country vast sums of money which have hitherto gone abroad. For the farmers themselves an alternative crop will be provided which will certainly be more profitable than corn, while leaving the land clean and in good condition for the following crop. The dry pulp will be very useful for stock, and this can be returned to the farm at a moderate price. Any land which will produce a good crop of mangolds will grow beet, though free working loams may bring the best results and be more economically worked. The cultivation of beet will appeal to all arable farmers, whether their holdings be large or small, and the new industry promises to become one of the most valuable features of "after the war" farming.

PASTURE *v.* TILLAGE.

Ever since the depression in agriculture set in towards the close of the last century, there has been a gradual decline of arable cultivation and a steady increase of pasture land in this country. Until quite recent years this fact was not generally regarded as an unfavourable symptom, the prevailing idea being that an increase of grass land meant an increase of live stock. That false impression has lately begun to fade from the minds of careful enquirers, and bids fair to become altogether exploded. Our best practical farmers have always held that the laying down of land to grass is a sure sign of the decadence of agriculture, and they regard it only as a refuge for farmers in distress who have lost their capital under the pressure of bad times and low prices, or else have been driven to such an unwelcome step by shortage of the labour supply. They absolutely deny that live stock increases in proportion to the increase of pasture, and assert that, sufficient capital being available, more stock will be carried on well cultivated land in addition to the corn produced. They admit that a man may be justified in abandoning

the plough to save himself from bankruptcy, though the hope of accomplishing that object lies only in reduction of expenditure, and certainly not in any increase of production.

New-laid pastures, even if well started and sown with the best mixtures, rapidly deteriorate after the second year unless scientifically and liberally manured, and that we know has happened to only a very small percentage of those laid down during the last thirty years. It is a common saying that it takes twenty years to make a good pasture, and so it certainly does if nature be left to do the work unassisted. In the meantime land so treated becomes practically derelict and represents in the aggregate an enormous loss to the nation. It is scarcely conceivable that in the new era, the dawning of which is already distinctly discernible, such a wasteful state of things will be allowed to continue, and it is fairly safe to predict that in the coming years the plough will come into its own again and that there will be a great reduction of that vast area of land now almost non-productive as poor pasture which, fifty years ago, was producing good yields of wheat and other crops.

SMALL HOLDINGS.

The days have apparently gone by for the indulgence in dreams of the bulk of rural Britain being cut up into small holdings. Notwithstanding the enthusiastic advocacy of a few "reformers," such a revolution was never likely to occur. The movement met with much encouragement in political quarters and strong legislation was adopted in its behalf. Under the Small Holdings and Allotments Act, 1908, up to the year 1913, the total quantity of land acquired was 182,022 acres, 157,883 acres of which had been let by County Councils to 11,021 small holders, and 476 acres sold to 42 small holders. This was the progress made in five years and the figures speak for themselves. At that rate of progression it would take centuries to make much impression on the old system of land tenure. The war arrested such progress as was being made, and since 1914 no further report has been issued. The movement, indeed, may be said to be practically dead, but is to be revived under another form. Experience has shown that to legislate and provide small holdings for all comers is one thing, but to induce men to take them on a comprehensive scale is another. Further, it has been found that when a man has secured his small holding it by no means follows that he will succeed with it, for there have been plenty of failures already. To gain a living from a small piece of land involves a laborious life, of which many soon tire, and the

majority of those who retain their holdings treat them as an adjunct to some other means of earning a livelihood.

Without describing the movement as an absolute failure, it is scarcely going too far to call it a disappointment. It is evident that the legislature regards it as such and recognises that the present scheme has its fatally weak points. Did it not do so it would hardly have been considered necessary to pass a special Act to provide small holdings for soldiers after the war. This has been done, and no man with a spark of patriotism or right feeling towards the brave men who are fighting our battles can do otherwise than heartily wish it success.

Every agricultural undertaking, large or small, requires a proportionate amount of capital to give it a chance of success, and the want of it has been the chief cause of past failures with small holdings. An attempt is made to meet this difficulty by the incorporation of credit banks with the new scheme. Then the principle of co-operation is largely invoked under the colony system, and this may make all the difference between success and failure. The general idea of a colony of small holders farming a large estate with a central depot, from which machinery and all requisites can be obtained on easy terms, and at the same time be used as a collecting place for produce and its advantageous sale, seems well conceived, and, if well managed, should lead to a happy success.

To what extent our soldiers will avail themselves of the offer of small farms at home is, at present, merely a matter of opinion. There are many, doubtless, who will decline to return to the counter and the office desk, but to these the colonies will offer a strong attraction, and emigration may take place on an unprecedented scale. If so, it will be all the better for the Empire at large, and probably also for the emigrants themselves. Whatever the proportion of those who elect to stay in the old country, the nation must do all in its power to provide homes and work for them, and the country-side will welcome their advent.

Should these soldier-colonies be a success, they will provide a working model for other aspirants for a rural life, and, ultimately, a system of small holdings may play a not inconsiderable part in our future agriculture.

LARGE SCALE PRODUCTION.

A powerful article recently appeared in the *Field*, under the above title, showing that farming on a large scale is the only way to make sure of getting the maximum amount of food from the land at the smallest possible cost, and, therefore, that large holdings must be

the best for the welfare of the country as a whole. That the facilities afforded on such holdings for the application of the best labour-saving machinery and the latest discoveries of science give a very great advantage to that description of farming cannot be denied; and the writer in question was probably right in his contention that the greatest results at the least cost are obtainable only on the large scale system, but that is not quite all that the country will demand from its agriculture in the coming years. It has learned a sharp lesson on the folly of driving the population from the country to the towns and would welcome any system which promised to bring people "back to the land." It is unlikely that "large scale production" with cut and dried machinery of management would do this, and we may be fairly certain that it will never become the predominant system. Yet it is evident that holdings of several thousands of acres will find their place, and already some large proprietors are preparing to try the experiment, the Duke of Marlborough, for instance, is arranging to take at least 5,000 acres of his Oxfordshire estate into his own hands.

But there is another movement going on which bids fair to outrival large scale production in importance and extent. Ownership instead of tenancy is taking a strong hold on the minds of our farmers. A very considerable number of farms in the market have lately been purchased by their tenants. The principle of ownership of land by its cultivator is receiving very wide and powerful support and can hardly fail to extend itself to farms of all sizes. No one expects the existing class of tenant farmers to disappear, but its numbers appear likely to diminish greatly.

On the whole then, as matters are moving at present, there is no general revolution of the system of land tenure in sight, though many changes are inevitable. A dead level of uniformity is neither necessary nor desirable, and there is plenty of room for all the four forms of occupation which have been mentioned above to be afforded a fair trial.

As a people, we are not given to heroic or forcible remedies, and time will show the respective merits of the huge holding, the small holding, the old-fashioned tenancy, and occupying ownership.

THE LABOUR QUESTION.

Important as it is, we have not to deal here with the abnormal state of the labour market during the war, but to consider what is likely to happen to it when peace returns. Opinions on that point vary very widely, but none of them are worth much, seeing that so

much depends on the attitude which the nation will assume towards its agriculture after the war. We are told in terms of the most positive assurance that, whatever happens, wages will never return to their old level, whether the supply be large or small, because the State will step in to prevent it by means of a "minimum wage." That may be so, but few, perhaps, give a thought to the gigantic changes which such action would involve. It is quite unthinkable that such a thing can be forced on the employers without some guarantee enabling them to meet it. Possibly there may be some extremists who would insist on a minimum of £1 per week, even with wheat at 25s. per quarter and all other produce at a proportionately low price, but common sense points to the absurd impossibility of such a proposition. A much more feasible one would be the setting up of a Labour Board to control wages, and fix them from time to time as the value of produce rises or falls. Public opinion is undergoing education on this subject, and will, in the long run, be guided by its sense of justice and expediency. It has already got so far as to declare through the medium of the press that the general rule for the future must be that a farm labourer's wages must be sufficient to enable him to live decently and rear a healthy family. That is, of course, what all desire, but the amount per week necessary for that purpose depends on the value of the sovereign, that is to say, upon how much of the necessaries of life a sovereign will buy, and this suggests a sliding scale of wages. The alternative to this course would be a guarantee to the employer of a price for his produce, which would enable him to meet the rate of wages fixed by law at an arbitrary level.

Speculation is rife as to the effect of the war on the future supply of labour, and the question is anxiously asked: "Will the men return to the land on being discharged from the army?" Probably a considerable portion will refuse to do so unless sufficient inducements are offered them. Especially is this likely to be the case with unmarried men without ties in their native villages. Labour was none too plentiful before the war, in fact, there was a decided shortage in districts adjacent to large industrial centres. Thus, as it will be quite unsafe to reckon on an ample supply, careful thought should be given without delay to the best means of securing it. If many of the young men decide to emigrate, in response to the schemes on foot to encourage them to do so, it is obvious that peace cannot bring with it as good a supply of labour as that existing before the war, and, for a time at least, there must be a shortage, against which there are no means apparently available likely to have much immediate effect, excepting, perhaps, very high wages. To establish,

therefore, a prosperous, numerous, and contented peasantry must be a work of time, but by no means an impossible task if undertaken with the co-operation of all parties, political and otherwise.

One of the worst grievances in the rural worker's lot has been the wretched little cottage in which he has had to live, and many a young man has migrated to the towns because of the impossibility of securing a cottage in his native village. The housing problem, about which so much has been said and written, is an urgent one, which must be solved before any real progress can be made. A decent home, with a garden of a quarter of an acre, is the first essential to a contented life.

What is called Profit Sharing has hitherto been very little discussed, but is not without its possibilities. Theoretically the idea seems sound and feasible enough as a means of attracting labour to the land. A very small percentage of the employer's profits would give the labourer an interest in his work and improve his status; at the same time adding to his self-respect and offering some hope of permanent improvement in his prospects. To the employer, it might be the means of ensuring better service of a more permanent character, and so recoup him for the small additional outlay.

CO-OPERATION.

Co-operation amongst farmers has been a plant of slow growth in this country, and even now one often hears the phrase, "farmers will never co-operate." Yet, looking back a few years, we see that steady progress has been made and that the principle is becoming better understood. Combinations for the purchase of requisites were found comparatively easy to form and have met with considerable success, but those for the sale of produce have met with much difficulty, in spite of the labour and money spent upon them by propagandist bodies. Still, sufficient has been done to show the advantages of organisation for sale, especially of the smaller products of the farm, such as poultry and eggs, and vigorous attempts have been made with dairy products with some measure of success. Co-operative bacon factories may be said to be on their trial, and many believe they have a great future before them, while cheese factories are claiming more attention and promise great things from new and improved methods of cheese-making.

Co-operation is a term with very wide application, and it includes mutual insurance and other such matters. It would be difficult

to place a limit to its possibilities. It is as yet only in its infancy in this country, and there is much to learn and much prejudice to overcome before the glowing promises of its early advocates can be fully realised. Possibly, under the new conditions which may arise after the war, more rapid progress may be achieved.

EDUCATION.

The possible effects of technical education on the future of British agriculture are so far-reaching that the mind becomes lost in their contemplation, for they are practically limitless. Who shall attempt to place any bounds to the discoveries of science and the results of their application to our dealings with the soil? In such matters we can only see a very little way forward and try to grasp the meaning of what is already known. What is really incumbent upon us, however, is to see to it that no stone be left unturned to secure the full advantage of the knowledge which the researches of science have placed in our hands, and it is highly gratifying to observe that this duty is receiving recognition in responsible and enlightened quarters at this critical period of the national life. Signs are not wanting that the years following the war will see a great revival in educational progress, especially in those branches of knowledge which most affect the material welfare of the people. Great efforts are likely to be made to instruct young men intended for agriculture in agricultural chemistry, which will assuredly play a great part in the future treatment of crops. To this may be added, at least, the rudiments of botany, mechanics, and veterinary science, without which no farmer of the future will be considered fully equipped. There is still far too much indifference to the power of science on the part of British farmers, and some means must be found to awaken them to a sense of its vital importance. There is also plenty of room for improvement in the kind of education given to the children of labourers, who should be specially trained for the work awaiting them. The scarcity of expert labourers has always been a trouble with farmers, and the few who are capable of tasks requiring any skill have been self-taught. It would be a great thing, too, if the future training of village boys (and girls, too), included lectures on the truer and higher meaning of life. They should be taught the "dignity of labour" instead of being filled with false ideals of what constitutes happiness. At the same time we must not try to deprive them of any worthy ambition, but should rather encourage the deserving with every hope of advancement.

CONCLUDING REMARKS.

The foregoing attempt to pass in review the leading topics connected with the past and future of British agriculture leaves many subjects untouched, which, though they may be considered of minor importance, may have considerable effect on the welfare of our rural population. Fruit-growing, market-gardening, poultry-farming, and pig-keeping for labourers and small holders, have not been mentioned, though much might be said of the future possibilities of each of them. All of them will appeal to the small holder in a greater or lesser degree, and are, therefore, likely to develop a larger aggregate production. They will, however, be subject to foreign competition as much as wheat and meat, and the profits derivable from them will, therefore, depend very much on the fiscal policy which the nation decides to adopt. We are thus brought once again up against the dead wall of uncertainty as regards what that policy will be.

After the war, problems will demand solution on which opinions cannot be otherwise than divided. These problems must, however, be approached in a different spirit to that which has characterised their discussion in the past. The nation will have passed through a fiery ordeal, which it is earnestly to be hoped will have purged it from the dross of party spirit, or so much of it that what remains will be comparatively harmless. The writer has been an optimist as regards the position and destiny of Britain which will result from this World War, and can see no reason to fear that she will take the wrong turning when it is over and the inevitable industrial struggle begins. Manufacturing industry and agriculture will join hands, for both will recognise at last that production is the bed-rock of a nation's prosperity. United they will be strong and will insist on a policy which will ensure the prosperity and happiness of the nation we love so well.

III.—THE IMPORTANCE OF LIMING.

By John Hughes, F.I.C., Agricultural Analyst for Herefordshire.

The agricultural value of lime as a natural fertiliser of the soil has been recognised from a very remote period. According to Pliny the Gauls applied lime with great success to their corn lands, while the Romans found an occasional dressing very beneficial to their vines and olive trees.

In this country the practice of liming, that is to say the appli-

cation of kiln-burned limestone, has been confined to certain localities. Thus, in the northern and western counties of England, in South Wales, and in parts of Scotland, liming used to be very popular and indicative of good farming; but in the southern and eastern counties where the soil is more calcareous, and where, the rainfall being less, the climate is drier, it has not been customary to apply lime in its ordinary caustic form, though much benefit was frequently found to result from dressings of chalk and chalk marl at intervals of about 20 years.

Formerly liming was associated with summer fallows, but with the decline of this special and certainly costly preparation for wheat, consequent upon the decline in value of corn, the old custom of applying lime to arable land during the summer and autumn appears to have been extensively given up, and the numerous ruined lime kilns in certain districts afford practical evidence of the fact.

The introduction of artificial fertilisers may also have contributed to the disuse of lime, though superphosphate, dissolved bones, and the various compound manures applied to root crops, being in themselves acid, are really exhausters of the lime in the soil so that the application of lime becomes even more necessary than formerly.

REASONS FOR APPLYING LIME.

(1) Lime is a necessary constituent of all naturally fertile soils, and, as is shown in Table I., is required by all farm crops in varying proportion.

(2) On clay soils it has a wonderful effect in decomposing the insoluble silicate of potash and rendering this important ingredient available as plant food.

(3) On soils containing much vegetable matter, such as peaty land, it corrects the excessive acidity and promotes the formation of valuable nitric acid compounds from the previously inert nitrogenous organic matter. Indeed, lime acts as the medium by which nitrification takes place, and the almost entire absence of nitrates in the water draining from the peat soils in Scotland—which abound in nitrogen—is probably due to the absence of lime.

(4) On damp soils lime improves the mechanical condition, making the soil more friable and more easily worked into a fine tilth, which is so important at seed time.

(5) Finally, lime, if used judiciously, may be truly regarded as the key for unlocking the hidden treasures of the soil, so that

larger and better crops may be produced, also for combating special diseases, such as finger and toe, for which it is regarded as a specific.

In excessive quantities, however, or if applied too frequently, liming is undoubtedly exhausting, and this fact has given rise to the saying that lime is good for the father but bad for the son.

Lime acts beneficially as an alterative on the substances contained in the soil, both organic and mineral, and therefore should not be applied in excess because the growing crop can only utilise a certain proportion of the plant food, which such liming has rendered available, and the excess is wasted, much of it being rendered soluble and liable to be carried away in the drainage water; the soil is thus proportionally impoverished for future crops.

Liming should be followed by manuring, and then the full benefit of both will be obtained. Indeed, unless the soil contains a sufficient supply of lime, the application of ordinary farmyard dung on arable land is frequently most disappointing in its results, especially in the case of root crops, such as turnips, swedes and mangolds; for the nitrifying process does not proceed satisfactorily unless there is plenty of carbonate of lime in the soil.

The following table is introduced in order to indicate the varying proportions in which lime is required by respective crops.

Though lime is usually applied to arable land it will be seen that cereal crops, such as wheat, barley, and oats, absorb comparatively very little, while for turnips, hops, and clover the figures are much higher.

Potatoes do not require much lime, and the soil of the Channel Islands, which produce, such excellent crops of early potatoes, contains only from ·25 to ·50 per cent. of lime.

It is satisfactory that during recent years there has been a very decided reversion in popular opinion in regard to the desirability of applying lime, not in the rough lumpy condition and large quantities of three or four tons per acre as formerly, but in a finely divided state known as ground lime and in as small a quantity as 10 cwt. per acre.

Probably the great success which has attended the use of Basic Slag in a fine powder has directed attention to the superior effect of lime when applied in the condition of a *fine powder*, for every 100 parts of Basic Slag contain fully 40 parts of lime in a specially fine state of division.

For instance, in Scotland the field experiments conducted at Kilmarnock College demonstrated that the largest increases of the

TABLE I.

AVERAGE CROPS REMOVE PER ACRE.

			Nitrogen.	Phosphoric Acid.	Potash.	Lime.
			lbs	lbs	lbs	lbs
Wheat	Grain	30 bushels	23	15	10	1
	Straw	.. ..	12	8	19	10
		Total ..	35	23	29	11
Barley		40 bushels	34	15	10	1
	Straw	.. ..	12	5	24	9
		Total ..	46	20	34	10
Oats		45 bushels	38	12	9	2
	Straw	.. ..	14	7	30	10
		Total ..	52	19	39	12
Meadow hay ..		1½ tons	49	13	57	29
Clover hay ..		2 tons	102	25	88	87
Beans		30 bushels	77	23	23	3
	Straw	.. ..	22	10	58	31
		Total ..	99	33	81	34
Hops	Flowers	10 cwt.	33	15	32	9
	Leaves	.. ..	29	21	32	67
	Bine..	.. ..	14	8	18	16
		Total ..	76	44	82	92
Turnips	Roots	17 tons	71	23	109	26
	Leaves	.. ..	49	11	41	49
		Total ..	120	34	150	75
Swedes	Roots	14 tons	74	17	64	20
	Leaves	.. ..	28	5	17	23
		Total ..	102	22	81	43
Mangolds	Roots	22 tons	96	34	192	25
	Leaves	.. ..	51	15	72	30
		Total ..	147	49	264	55
Potatoes	Tuber	6 tons ..	47	24	76	3
	Haulm	.. ..	20	3	2	23
		Total ..	67	27	78	26

various farm crops were obtained from annual applications of 10 cwt. per acre of lime.

Profitable results were got over a period of eight years from annual applications of 5 to 10 cwt. per acre; but 1–2 and 4 tons an acre applied annually were all very unprofitable. Indeed, this is just what might be expected after a little careful consideration.

Freshly burned lime on exposure to the air rapidly absorbs moisture and becomes converted into hydrate of lime, which in time absorbs carbonic acid from the air and water in the soil, becoming converted gradually into its original form of carbonate of lime.

Now according to the writer's experience :—

One part of caustic lime dissolves in 833 parts of cold water.

One part of carbonate of lime requires 22,222 parts of water to be dissolved.

As lime exerts its chemical action upon the organic and mineral ingredients in the soil, when it possesses its original caustic character as hydrate of lime, it is obvious that it must be wasteful to apply too large quantities, inasmuch as the ordinary farm crops take up comparatively small amounts of lime varying according to Table I. from 11 and 10lbs. per acre in the case of wheat and barley, to 75lbs. for turnips, and 92lbs. for hops, and the excess not only of the available lime, but also the excess of the other plant food ingredients rendered available and soluble in the soil by the alterative action of the caustic lime, are, as previously mentioned, liable to be washed away in the drainage water and lost as plant food.

Obviously therefore the modern idea of applying lime in small but frequent dressings is both scientifically and practically correct.

THE QUALITY OF LIME.

The quality of the lime applied in different localities varies enormously and to some extent may account for the varying proportions in which it has been used in the past.

Local arrangements and the cost of transit may oblige the use of local lime, but whenever possible the most suitable lime should be selected. For agricultural purposes the purest lime, the lightest in weight per bushel, the one that absorbs the most water during slaking and afterwards swells out to the largest bulk, is the most suitable.

In Tables II., III, and IV. analyses are given respectively of superior agricultural lime, inferior agricultural lime, and finely ground lime.

TABLE II.

SUPERIOR AGRICULTURAL LIME.

	Dorking White.	Old Radnor.	Derbyshire Lump.	Ifson White.
Caustic Lime	96·96	96·76	89·09	89·29
Carbonate of Lime	Trace	Trace	5·00	5·45
Magnesia..	·18	·50	·46	·07
Oxides of Iron and Alumina ..	—	·70	·60	·50
Insoluble Silicious Matters ..	1·29	·30	2·10	1·20
Water and Undetermined ..	1·57	1·74	2·75	3·49
	100·00	100·00	100·00	100·00

Good agricultural lime, fresh from the kiln, should weigh from 50 to 60 lbs. a bushel, should absorb nearly its own weight of water, and on slaking increase in volume from 2 to 2½ times its original bulk, and break up into a fine powder which will allow of uniform distribution either broadcast or through a drill.

Good lime absorbs water and carbonic acid very quickly, and as will be seen from the above analyses two of the samples have absorbed a considerable amount of carbonic acid, thereby converting about 3 per cent. of the original caustic lime into the comparatively mild alkaline carbonate of lime. Therefore in reporting upon the quality of lime the respective proportions of caustic and carbonate of lime should be always stated in the analysis.

Carbonate of lime may exist in the lime as a consequence of the original limestone not having been properly burned owing to insufficient fuel being employed.

TABLE III.

INFERIOR AGRICULTURAL LIME.

	Glamorganshire Lias.	Monmouthshire Lias.	Worcester Lump.	Leicestershire.
Caustic Lime	69·38	65·78	67·33	47·20
Carbonate of Lime	2·50	3·93	3·93	10·61
Magnesia..	1·26	1·33	1·29	17·13
Oxides of Iron and Alumina ..	7·01	9·20	4·40	7·40
Insoluble Silicious Matter ..	16·90	16·60	14·30	5·30
Water and Undetermined ..	2·95	3·16	8·75	12·36
	100·00	100·00	100·00	100·00

It will be seen from the above analyses that these samples are not only much poorer in caustic lime and contain varying quantities of carbonate of lime, but are impure from the presence of oxide of iron, alumina, and silicious matters.

The lias lime of Monmouthshire and Glamorganshire are splendid limes for building purposes, possessing hydraulic properties which cause such lime to set under water. This is due to the fact that most of the insoluble silicious matter exists, not as sand, but as minutely divided silica in a gelatinous condition, which combines with the lime on setting, forming a hard concreted mass like cement. Indeed, it is this amorphous silica that constitutes the active factor in Portland Cement, rendering it superior to ordinary mortar.

Good cement contains about 22 per cent. of such gelatinous or amorphous silica, and the quality of ordinary lime for building purposes depends upon its similarity in this respect to cement.

Thus the Greystone Dorking lime contains about 9 and Aberthaw 15 per cent. of such amorphous silica.

The writer has made a special examination of the ancient mortar as existing in our old Castles and Abbeys and it may be mentioned that the excellence and great durability of the mortar in Caerphilly Castle, Corfe Castle, Tintern Abbey and Whitby Abbey, is due to the presence of 5–6 and even 7 per cent. of this peculiar form of silica. But this property of setting into a hard concreted mass is not favourable to future agricultural results, and when possible such silicious lime should not be selected for use on the farm.

The Leicester lime is really dolomite containing a much larger proportion of magnesia, which possesses only a feeble caustic character, and is therefore not usually preferred for dressing either arable or pasture land, though on account of proximity it is no doubt extensively employed because of its lower price, especially in the form of ground lime.

TABLE IV.

FINELY GROUND LIME.

	Derbyshire.	Shropshire.	Monmouth.	Hereford.
Caustic Lime	88·60	44·86	40·41	56·73
Carbonate of Lime	5·10	18·40	12·27	10·90
Magnesia..	·50	1·01	1·36	1·62
Oxides of Iron and Alumina ..	·70	3·90	8·60	5·01
Insoluble Silicious Matters ..	2·20	23·10	23·80	21·60
Water and Undetermined ..	2·90	8·73	3·56	4·14
	100·00	100·00	100·00	100·00

Commercial ground lime should consist of freshly burned lime (quick lime) which has been ground into a fine floury powder. It should therefore be similar in quality to good caustic lime; but it

is often impure and contains frequently less caustic lime, more carbonate of lime and more useless insoluble silicious matter and Oxides of Iron and Alumina.

The above Table IV. represents the varying composition that may be expected in such a material and shows how very necessary it is that some guarantee of quality should be given when making the purchase. Ground lime naturally costs more than ordinary lump lime from the kiln, on account of the expense of grinding, though when the requisite machinery has been put up and mechanical arrangements for automatic feeding carefully contrived, the extra cost should not be more than 5s. a ton.

As finely ground pure lime has a very caustic irritating effect on the eyes, nose and throat, and is, moreover, very light and dusty, it is necessary to be careful in its application to the land, and where possible it should be applied through a machine.

Ground lime, on account of the impurities so often associated with it, usually weighs much more per bushel than good quick lime fresh from the kiln, so that when a bushel weighs 80 to 90lbs. the caustic quality is probably inferior, and the percentage of lime low.

The Derbyshire sample, however, shows that commercial ground lime can be obtained of good quality, and it will repay a farmer to make careful inquiry and arrange to obtain the best quality of agricultural lime.

THE USE OF CHALK.

The application of chalk, which is a soft amorphous kind of carbonate of lime, has been recognised as of great utility on certain land for generations, but its use has been restricted usually to the immediate localities where it was easily obtainable and at a low cost; because being associated with flint stones and often damp by reason of the hygroscopic moisture retained, it would be too bulky to be economically carted any considerable distance.

In the south of England, however, empty coal ships are loaded with chalk as ballast on return trips to the north, the price paid for same being 2s. 6d. a ton delivered alongside quay.

Recently chalk has been imported into the Channel Islands as the granite soils of Guernsey and Jersey do not contain more than ·50 per cent. of lime, and ordinary quick lime would destroy the valuable humus which is so useful in conserving the moisture necessary to the rapid growth of the early potatoes.

In the past, chalk has been chiefly applied to grass during the autumn or winter, being carted on the fields and the lumps spread

as uniformly as possible before the advent of frosty weather, so that the water contained may freeze and expand the lumps, and when the thaw comes they may break up into a fine powder capable of distribution by the use of chain harrows.

Chalk is little soluble in cold distilled water, one part requiring 22,222 parts of water to become soluble, but in water charged with carbonic acid it becomes readily dissolved and passes into the drainage in the form of bicarbonate of lime, which consists of two equivalents of carbonic acid combined with one equivalent of caustic lime.

It is the presence of this bicarbonate of lime that renders ordinary drinking water temporarily hard, but on boiling one equivalent of carbonic acid is driven off, and the remaining carbonate of lime, being insoluble in water and deprived of excess carbonic acid, falls to the bottom of the boiler or kettle forming the objectionable scale which has to be cleared out from time to time.

In addition to carbonic acid, there are other acids, such as humic and ulmic acid, of vegetable origin, which exist in the soil and exert a solvent action on the various mineral ingredients which afford plant food.

Indeed, this fact has induced the use of citric acid to be recommended by different chemists as a standard solvent. Thus Wagner has suggested a 2 per cent. solution shaken for half-an-hour, while Dyer has suggested a weaker solution of 1 per cent. to be in contact with the soil for a period of seven days, which is a great objection to its practical utility.

The writer in 1901, in a paper on "Basic Superphosphate" read before the Society of Chemical Industry, suggested a still weaker solution of citric acid, namely ·10 per cent., consisting of 1 part of citric acid dissolved in 1,000 parts of cold distilled water which represents an acidity absolutely less than that possessed by the sap of any farm crops, so that any lime, phosphoric acid, or potash dissolved out by such a solution after 24 hours' exhaustion may fairly be regarded as existing in a form available for plant food.

If this citric acid solution be applied respectively to pure, dry, finely ground lime and to finely ground, pure, dry chalk for 24 hours with occasional stirring, the following interesting results are obtained.

RELATIVE SOLUBILITY OF LIME AND CHALK.

One part of caustic lime dissolves in 809 parts of this weak 1 in 1,000 solution.

One part of chalk dissolves in 984 parts of such solution.

As 1 part of carbonate of lime in the form of pure chalk consists of ·56 lime and ·44 carbonic acid, it follows that ·56 lime is dissolved by the above 984 parts of this citric acid solution.

Consequently by calculation it follows that 1 part of actual lime existing in 1·78 parts of chalk is dissolved by 1,757 parts of this 1 in 1,000 solution (·10%) of citric acid; whereas 1 part of pure caustic lime is dissolved by 809 parts of same solution.

Therefore, though caustic lime is about 27 times more soluble in cold distilled water than chalk, we find that in this weak ·10 citric acid solution lime existing as caustic lime is only about twice as soluble as lime existing in the form of chalk. If, therefore, chalk can be dried and reduced by grinding to the same state of fineness as caustic lime it will be sufficient if one ton of such ground chalk be applied per acre instead of 10 cwt. of ground lime.

Rough chalk in lumps can in many districts be obtained at 3s. to 4s. a ton on rail as against 12s. to 15s. a ton for quick lime.

Further, the mild chalk, while it satisfies all the necessary bacterial action required for the production of nitrates, does not burn and consume the vegetable matter in the soil which is so valuable as plant food and for the retention of moisture.

Indeed, on all light soils, such as gravel, sand, and granite, the use of ground chalk can be confidently recommended as a suitable and economical form of applying lime to arable as well as pasture land.

The red soils of Gloucester, Hereford, and Worcester which are naturally poor in lime, would be greatly benefited by the application of finely ground chalk rather than by dressings of caustic lime.

Indeed, when it is considered that caustic lime, especially if finely ground, rapidly becomes converted into chalk, and that the original caustic action soon becomes reduced into a very mild alkaline effect, it seems a waste of money to purchase the more expensive caustic lime for all light soils, such as gravel, granite, and sand. So complete is the transformation of caustic lime to the state of carbonate of lime that, according to the writer's analyses of mortar taken from the interior of *old walls* and not apparently exposed to the air, the whole of the lime was found to exist as carbonate, silicate, or sulphate, there being only a mere trace of caustic lime present.

At waterworks, where Clarke's process of softening by the addition of lime is carried out, there is produced a specially fine precipitate of carbonate of lime, which settles at the bottom of the tank, and is removed after subsidence of the flocculent particles.

The calcareous sludge so formed, after being dried by exposure

to the air and protected from rain, would furnish a particularly suitable form of lime for soils deficient in this important element.

I understand that the authorities would be glad to get rid of this dried sludge at quite a nominal price to cover the cost of putting into trucks so that it could be delivered within a 100 miles at about 5s. a ton.

The good effects of a dressing of chalk has been strikingly demonstrated on the red sandy soil of the Woburn Experimental Farm, whereas at Rothamsted one field, Geesecroft, formerly used for experimental purposes had to be abandoned for such purposes in consequence of the absence of calcium carbonate (carbonate of lime) in the soil.

The following analyses represent soils from different localities that may be regarded as typical of land which would be greatly improved by a dressing of chalk.

TABLE V.

SOILS WHICH WOULD BE BENEFITED BY CHALK.
(Composition in the air-dried state).

	No. 1 Jersey.	No. 2 Yorkshire.	No. 3 Devonshire.	No. 4 Lincolnshire.
Water (lost at 212°F.) ..	1·60	1·38	1·64	1·98
*Organic Matter and Combined Water	3·32	3·44	6·92	4·60
Oxides of Iron and Alumina ..	3·21	5·48	7·80	4·38
Lime	·47	·78	·41	·24
Magnesia	·20	·32	·09	·11
Potash	·33	·17	·19	·12
Soda	·11	·10	·07	·06
Phosphoric Acid	·13	·18	·14	·14
Sulphuric Acid	·06	·03	·03	Trace
Insoluble Silicious Matters ..	90·57	88·12	82·71	88·37
	100·00	100·00	100·00	100·00
*Containing Nitrogen	·18	·15	·27	·17

No. 1 represents the average quality of Jersey soils on which large crops of early potatoes are raised with the aid of about 8 cwt. per acre of a special high class manure containing 16 to 18 per cent. soluble phosphate 7 to 8 per cent. ammonia (derived from sulphate of ammonia) and 2 to 3 per cent. of potash. Potatoes do not require much lime as the soil only contains ·47 in 100 parts, but for following crops, such as turnips or swedes, more lime would be beneficial, provided it be in the

form of soft chalk finely ground; for caustic lime would burn up the already small percentage, 3·32, of organic matter.

No. 2 represents a light, silicious soil from the neighbourhood of Driffield on which phosphate of lime in an alkaline form, such as basic superphosphate, has become so popular that the local farmers will not now use the ordinary acid superphosphate on this kind of soil.

No. 3 represents a light porous soil from Devonshire, which produces fair crops of potatoes, but fails to yield economic crops of turnips or swedes.

No. 4 represents a soil from Braceborough on which the turnips were badly affected with finger and toe and canker at the roots, though eight years had elapsed since turnips had previously been sown. The land, however, was said to produce good crops of oats.

All four soils are very deficient in lime and also in vegetable matter; so that a dressing of chalk would supply the former without destroying the latter, which are points of importance to be considered by the practical farmer. A ton per acre, if in a finely ground state, would be a sufficient quantity to be applied, and if possible it should be done during the autumn or winter months.

At Rothamsted as small a quantity as 300lbs. per acre of finely ground chalk on grass produced a very appreciable effect, but it was only after two years that the results were sufficiently marked to be noticeable, both in the weight of the hay produced, and in its botanical composition, which showed an increase of over 20 per cent. in the leguminous herbage, such as clover and vetchlings, compared with the herbage from the plots which had not been dressed with chalk.

Indeed, the agricultural value of chalk has been greatly undervalued and its use sadly neglected, and it is hoped that the foregoing remarks may induce its more extensive application on light soils deficient in lime.

GROUND LIMESTONE.

This material should not be confused with ground lime. It consists, or should consist, of finely ground limestone rock, whereas ground lime should consist of the quick or caustic lime produced by the burning of the original limestone subsequently ground into powder.

Obviously ground limestone being of a crystalline character, and much harder than soft chalk, is scarcely likely to prove an

economical means of supplying lime, except for soils that are specially rich in vegetable matter, and well supplied with moisture.

Some ten years ago, however, attention was forcibly directed to the use of ground limestone by the success which attended some experiments in the liming of meadows carried out by the Lancashire County Council in which comparative tests were made between ground limestone delivered at the railway station at 6s. per ton, cob-lime at 13s., and ground lime at 23s. 3d.

It should, however, be mentioned that it was necessary to apply $1\frac{3}{4}$ tons of the ground limestone in order to supply as much lime as would exist in one ton either of cob or ground lime, so that the relative cost per acre was 11s. 4d., also the cost of carting and distributing would be more in the case of the ground limestone, though being in bags it was much easier to handle.

The Lancashire experimenters felt justified in asserting that, taking into account the results obtained in the two years 1905–1906 the application of lime in the form of ground limestone on the particular kind of meadow land operated upon, was more effective and also more economical than lime either as cob-lime or as ground lime.

Probably the effectiveness of such ground limestone was largely due to the specially fine powdery condition in which it was applied, while the absence of causticity would render the distribution much more convenient and less irritating to the eyes of the men employed.

In 1877 the writer was officially engaged by the Planters' Association to visit Ceylon and report on the chemical composition of the soils and fertilisers employed in the growth of coffee and tea; and after making a continuous seven weeks' tour through the planting districts, found that the soil being generally derived from granite, was naturally poor in lime, of a ferruginous character, and associated with a heavy annual rainfall, and there being no chalk available in Ceylon, recommended that the coral found on the sea shore should be finely ground and applied in its natural unburned state as an economical form of applying lime as carbonate.

This recommendation was suggested by the fact that sea shell-sand, consisting largely of minute particles of shells, had been applied in Cornwall and parts of Devonshire to arable and pasture land for generations with beneficial results.

Indeed, on consideration it is not at all remarkable that finely ground limestone or coral (which is a very pure form of carbonate of lime) should give satisfactory results when applied to particular kinds of soil, because basic slag, however finely ground it may be, is a hard fused material, and yet what a wonderful effect it has

produced in renovating and improving the quality of the herbage and the yield of hay on pastures containing a fair amount of vegetable matter associated with a plentiful supply of moisture, the combined effect of which acts as a solvent of the apparently insoluble basic slag.

SEA SHELL-SAND.

For generations large quantities of sea shell-sand haye been applied for agricultural purposes on the north coast of Cornwall and Devonshire.

This shell-sand consists of very minute particles of shells associated with varying proportions of ordinary quartz sand. Thus, at Padstow the proportion of carbonate of lime, in the form of broken and very finely powdered shells, amounts to as much as 80 per cent., but farther up the Bristol Channel the proportion falls to 50, and at Hartland Point there is only as much as 30 per cent.

This shell-sand is sent up country in barges and applied to the soils which are locally supposed to require it, on account of deficiency of lime, but which on analysis are often found to contain from ·09 to 1·50 or sometimes as much as 3 per cent. carbonate of lime.

Occasionally it is mixed with farm-yard dung before being carted on the land, and when straw, as bedding, is scarce it is put down in cow-houses and mixed at once with the dung and urine, and though its absorbent properties must be small, there is no doubt it affords lime in a sufficiently available form for the land upon which it is applied, as the practice of "sanding the land" is recognised as a well established farming custom in that locality.

DURATION OF THE EFFECT OF LIME.

How long does the effect of liming last and what allowance should be made to the out-going tenant for the cost of the same, are important points for the consideration of valuers.

Reference to Table I. shows that cereal crops, such as wheat, barley, and oats, remove from the soil very little lime, only from 10 to 12lbs. per acre, of which about 9lbs. exists in the straw that under good farming is usually returned to the land.

Meadow hay absorbs about 30lbs., swedes and turnips 40 to 75lbs., clover 87lbs., and hops about 92lbs.

No average farm crop, however, removes as much as 100lbs. per acre, and compared with the quantities of nitrogen, potash, and phosphoric acid removed by the various crops, the figures for lime are really very small.

Lime therefore is essential to fertility, not on account of the

amount required by farm crops, but because it acts both chemically and mechanically on the organic and mineral contents of the soil, as an improver and alterative, rendering the plant food more available and at the same time producing a better tilth in heavy soils and conserving moisture in light ones.

It is on strong land and stiff clay that the ordinary caustic or quick lime is most effective, rendering such soils drier and more easily worked.

In the reclamation of boggy or peaty land the application of large dressings, 10 to 15 tons per acre, of caustic lime, combined with draining, are recognised as the best methods of treatment. On light soils—the sands and gravels, also granites—caustic lime, for reasons already mentioned, is not desirable (except in small dressings as 10 cwt. per acre), and chalk in a finely divided state is a much more suitable form of applying lime.

Soils that on analysis are found to contain less than ·50 of lime, representing ·89 carbonate of lime, will certainly be benefited by a dressing either of caustic lime or chalk, according to their physical character, whether heavy or light. Indeed, soils containing as much as 1 per cent. of lime representing 1·78 carbonate of lime, in many cases may be improved by judicious liming.

As regards the quantity of lime, stiff clays will no doubt economically respond to dressings of as much as five tons quick lime per acre, carted on to the field, spread in small heaps during the autumn months, and scattered with shovels after being allowed to slake for a week or ten days.

The effect of lime is quicker and more noticeable in proportion to the deficiency of lime in the soil. In small dressings the action seems to be very slow, or at least difficult to detect until some months have elapsed, but the larger the dressing the quicker the apparent effect.

The beneficial effects of liming, however, have often induced the farmer to repeat the dressing rather than to apply dung, and he has been greatly disappointed to find that there was no satisfactory result compared to that produced by the first dressing. Hence the saying that liming is good for the father but bad for the son.

Liming should be done judiciously and after careful inquiry as to whether the soil requires it or not, and should be followed by manuring.

In arable land the presence of sorrel—spurrey and corn marigold—are reliable indications of the absence of lime; while in pastures the absence of leguminous plants and the growth of the common bracken fern are sure signs that lime would be beneficial.

CAUSTIC LIME CHANGING TO CARBONATE OF LIME.

The great rapidity with which caustic lime, whether in solution or in solid form, absorbs carbonic acid and becomes converted into carbonate can readily be demonstrated as follows :—If a saturated cold water solution of fresh caustic lime be clarified by filtering through blotting paper, and the clear liquid so obtained be placed in a glass beaker or tumbler it will be noticed that a scale forms on the surface after standing for a few hours. On stirring, this scale, which consists of carbonate of lime, falls to the bottom of the glass vessel, and in a few days quite a large quantity will have accumlated.

The following experiment shows the rapidity with which caustic lime in a *solid* form becomes converted into carbonate of lime :—A specimen of freshly burned lime containing 91·61 per cent. total lime of which 2·29 existed as 4·09 carbonate of lime, was mixed in equal proportions with some dried soil free from carbonate of lime and exposed to the air for one week. A portion of the mixture was then analysed and the percentage of carbonate of lime was found to have risen to 47·75 per cent. in the original lime. After standing another week the remaining portion of the mixture was analysed and the percentage of carbonate of lime was found to have increased to 52·10 per cent. of the original lime.

Assuming that the subsequent rate of conversion was similar to that found at the end of the second week, namely, 4·35 per cent., the whole of the 91·61 caustic lime would be converted into 163·59 parts carbonate of lime in about 28 weeks.

If so, it would appear that the caustic effect of freshly burned lime becomes exhausted during the first year and that afterwards the lime exists in the soil as carbonate of lime and should be regarded and valued as such. Of course such finely divided carbonate exerts a beneficial effect in the conversion of the mineral and organic constituents of the soil into available plant food for many years.

At Woburn the application of chalk on the experimental plots, some twenty years ago, is still producing satisfactory results over the unchalked plots. This carbonate of lime is rendered soluble in water by the combined action of carbonic acid and rain, which transforms it into Bi-carbonate of lime, some of which is absorbed through the roots of the growing crop, while the excess is carried away in the drainage water.

At Rothamsted it has been found by actual measurement and analysis of the drainage water from the experimental plots in Broadbalk field, which contains about 5 per cent. of carbonate of

lime in the first nine inches of soil and ·50 in the sub-soil, that 560lbs. of lime equal to 1,000lbs. carbonate of lime are annually carried away in the drainage. Therefore, the heavy dressings of lime formerly applied must have been decidedly wasteful, as comparatively a very small proportion was absorbed by the crop, while the caustic action on the soil would be limited to a few months, so that the greater portion would remain in excessive quantity in the soil, far beyond the ordinary requirements either of the soil or the crop and subject to the annual loss through drainage.

On arable land the duration of the effect of lime is much shorter than in the case of either pastures or of meadows reserved for hay, because of the frequent ploughing and harrowing and the natural tendency of lime to sink downwards.

The nature of the soil, whether porous or heavy, will also have much to do with the length of the period during which the effects of lime will be visible in the crops produced, so that no actual time can be laid down, or any fixed allowance made in respect of liming.

The valuer must decide this point according to the actual circumstances of each case, because, under the existing terms of the Agricultural Holdings Act, it is only the amount of benefit to the in-coming tenant that is to be allowed for, not the actual cost of the liming or manuring that may have been incurred by the out-going tenant.

On pasture or on meadows reserved for hay, lime is best applied in the form of a compost of about one part of freshly slaked lime to 5 or 6 parts of pond or ditch mud, road scrapings, or ordinary earth, well mixed together and allowed to remain in a heap for a few weeks before application. If applied directly to the grass, unless in a finely divided state such as ground lime, it is a long time before the lime can come directly in contact with the soil and exercise a beneficial effect on the plant food constituents.

CONCLUSION—LIME AS A SUBSTITUTE FOR POTASH.

At the present time, when owing to the war the various potash salts such as sulphate, muriate and kainit, cannot be obtained from Stassfurt, and other sources of potash are so expensive, there is an additional and very special reason for the application of lime either as caustic lime or as carbonate of lime according to the kind of soil and the cost of carriage.

Lime is an alkaline earth and furnishes the most economical substitute for the actual alkali-potash.

Many years ago the late Sir John Lawes pointed out that the ash

or mineral portion of a leguminous crop, such as clover, when produced on land well supplied with potash, contained 32 per cent. of potash and 22 per cent. of lime; but when produced on land poorly supplied with potash but well supplied with lime, the ash contained 32 per cent. of lime and only 14 per cent. of potash.

The remarkable effect of producing a wonderful growth of white clover, so often ascribed to a dressing of 10 cwt. per acre of basic slag, is no doubt chiefly due to the large proportion of lime, 40 to 44 per cent., supplied in a particularly fine state of division.

On soils deficient in lime and also deficient in potash, a dressing of 10 cwt. good ground lime or 1 ton of crushed chalk will be found very effective if applied some months previous to the sowing of clover, peas, beans, vetches, etc.

Experiments with different kinds of lime at Woburn have shown that Buxton and chalk lime have given the best results, then follow the lias and oolite limes, while magnesium lime was found to be distinctly inferior to any other.

IV.—SOME PRACTICAL QUESTIONS IN RELATION TO THE PIG INDUSTRY.

By James Long, Author of the "Book of the Pig."

The pig industry in England has long been most unsatisfactory. In Scotland it is still worse, for the Scottish farmer has never taken any interest in the work of breeding or feeding. How far disease and the restrictions which have been applied by the Government have controlled the conditions it is not possible to say, but for some reason or other farmers have not taken to the work—so far as Great Britain is concerned—so well as the farmers of Ireland—still less of the farmers of the other leading agricultural countries of the world. Let us make this position clear by quoting the number of pigs in the various countries in a recent year before the war—these being the latest returns available.

Total Number of Pigs in Each Country in 1912.

England	2,270,154
Wales	226,516
Scotland	159,127
Ireland	1,323,957

Thus Ireland, with a smaller population than Scotland, owns over eight times as many pigs as the latter and half as many pigs as there are in England and Wales, although her population is less than one-eighth. This disparity is almost equally marked when we compare the number of pigs kept in continental countries with our own. There were in—

France	6,903,000	1910–11
Germany	21,923,000	1910–11
Belgium	1,348,000	1910–11
Austria-Hungary ...	14,012,000	1910–11
Denmark	1,467,000	1909

The pig population of England and Wales in 1916 was 2,167,000 showing a decrease of 10·4 per cent. on the previous year.

Now let us refer to the position immediately before the war. According to the official return of the 15th of July, 1914, the price of bacon pigs in the great markets of the country varied from 6s. 4d. to 7s. 8d. a stone—first quality. Porkers cost from 6s. to 8s. 3d. Store-pigs, 8 to 12 weeks old, from 16s. at Norwich to 28s. at Lincoln. British pork cost in London 56s. to 63s., at Birmingham and Leeds. Wiltshire bacon cost 80s., green, 86s., dried or smoked. Irish bacon 76s. and 81s., while Danish bacon, green, cost 70s. in London and Bristol. Dutch bacon was not then in quotation. On the 1st November, 1916, bacon pigs were quoted in the markets already referred to from 10s. 6d. at Hereford to 14s. at Penrith; porkers from 12s. 3d. at Hull to 15s. 6d. in Wales; while store-pigs cost from 19s. at Ashford to 36s. at King's Lynn. British pork cost 112s. in London to 138s. 8d. in Birmingham, while frozen pork cost from 98s. to 100s. Wiltshire bacon was quoted at 132s. for green in Bristol to 140s. dried or smoked; while Irish bacon varied from 124s. for green to 131s. for dried or smoked—the London price being 118s. and 124s. At the same time Danish bacon was 118s. to 120s., and Dutch bacon 110s. to 112s. The supply of fat pigs in the markets in 1914 had reached 294,000 to July 15th, and of store-pigs 95,000, as against 344,000 and 105,000 in the years 1911–13. On November 1st, 1916, the supply of fat-pigs had reached 487,000 as compared with 515,000 in 1913-15, and of store-pigs 131,000, as compared with 165,000. The markets at the latter date were much fuller for the previous week than in 1914.

It will now be well, before discussing the general question relating to production, to deal with a few facts which have been elicited by the carcase competition at Smithfield, which I have carefully examined in each section of live-stock for a number of years. These

facts indicate, not only the more popular weights of porkers and bacon pigs, and the price which they realise under the hammer at the hands of the butchers of the metropolis, but the actual type of pig which the public demand and the proportion of dead to live weight. In the class for porker-pigs not exceeding 100lbs. alive, the first prize was taken by a pig weighing 84lbs. alive and 66lbs. in the carcase, showing a carcase weight of 78 per cent. This was a Berkshire, providing small joints but nice fleshy meat of high quality—the fat at the heaviest portion of the back varying from ¾ of an inch to 1 inch in thickness. The second prize pig weighed 90lbs. alive and 71lbs. dead, also showing a carcase weight of 78 per cent. The lean was streaky and covered with only ¾ inch of fat. The third prize pig weighed 83lbs. alive and 63lbs. in the carcase, showing a percentage of 75½. In this case the fat over the loin was only half an inch thick. The whole class—and this applied more or less to every class in the exhibition—was filled with pigs which exhibited a much smaller proportion of fat than was common in earlier days; in the past, I have sometimes measured three inches of fat on the carcase of a prize pig.

Take one more example from pigs above 160lbs. in weight and not exceeding 240lbs., best suited for the manufacture of bacon. The first prize weighed 219lbs. alive, and 178lbs. in the carcase, showing 81 per cent. of carcase weight. This pig was ten months and four weeks old, and was covered with 1½ to 2 inches of fat on the back. The second prize pig at eight months old weighed 207lbs., with a carcase weight of 81 per cent., and it was somewhat leaner than the other; while the third prize weighed 218lbs. at 7½ months, and showed 83 per cent. of carcase weight. Apparently pigs of this weight can be fed in seven months, or at the outside eight months, where the quality is suitable and the feeding carefully arranged. It is worthy of remark that in the porker class referred to the prize pigs were respectively 4 months, 3½ months, and 3 months old, so that these animals, which sell better than pigs of larger size for pork, realise higher prices, cost much less to feed—apart from the fact that much time is saved in the process—and are much more economical to cultivate than pigs of larger size, whether they are intended for bacon or pork. Nothing in connection with the subject of pig feeding is more important than the fact—to be emphasised later on—that as age increases the quantity of food required to make each pound of live weight also increases, so that the longer a pig is kept the less profit it realises, while, conversely, the more quickly it is fed for slaughter the better it pays. I have observed that, under the hammer, fat pigs, like fat

sheep, realise at the hands of the butcher less money per stone—and sometimes considerably less—than pigs with a smaller proportion of fat. The public do not like excessive fatness, although, from an economical point of view, this is contrary to their own interest, inasmuch as the food provided upon a fat pig in proportion to the waste is much larger than is the case with a lean pig. Apart from this fact, the fat of the meat is all food, whereas the lean or muscular portion contains a very large proportion of water and some indigestible fibre.

The size of a sow governs the weight of her litters and their economical value for feeding. If a litter produced by a sow of a large breed is weighed side by side with a litter produced by a pig of a small breed, it will be found that the former weigh considerably more at birth. Age also controls the size of the litter. The produce of a gilt is smaller, both in number and weight, than the produce of a mature sow; while the produce of a mature sow is similarly larger and heavier than the produce of a young sow. The importance of this lies in the fact that young pigs of a large breed are more quickly fed for market, whether for pork or bacon, than pigs of a smaller breed. Thus, if a porker of a large breed is ready in 16 weeks, it may take 20 weeks or more for a pig of a smaller breed to attain the same weight, but I believe it will also be found that the food consumed by the pigs of the large breed in the shorter time of feeding will be quite equal to that consumed by the pigs of the smaller breed. It pays, however, to feed well when the process is followed by a rapid gain in weight. In other words, the quicker pigs are ready for market the finer is the quality of their meat, and the smaller the quantity of food they consume in the production of a pound of live carcase weight. Quick feeding is therefore doubly advantageous to the feeder and breeder, inasmuch as he is able to turn over his money more quickly as well as to obtain a better price in the market at a smaller cost for food.

What has been said will confirm the preference for the large varieties of pig. Since 1851, when the Large White York made its first appearance in the Show-yard, where it created great astonishment, little was done in the promotion of size in pigs until the appearance of the Red Tamworth, which I remember well, at the Royal, about 30 years ago, where classes were provided for it, largely owing to the efforts of the late Mr. Allender. To this day the Tamworth retains its reputation, but it is not bred throughout the country—possibly owing to its colour. The Tamworth, however, if not one of the largest breeds, comes between these and the Berkshire which, during the same period, has been immensely improved.

It is scarcely a century ago that the pigs of these Islands were all absolute mongrels—lanky, flat-sided, long in the head, with huge ears, and plenty of coarse hair. One of the great qualifications of the pig in those early days was its ability to walk to market. Now, however, instead of 18 months or more in the preparation of a pig for slaughter, at a cost which would exceed the value of the animal in the market, porkers are ready, as we have seen, in 16 weeks, while bacon pigs can be fed in another 10 weeks—the meat in both cases being less fat and more tender. The Tamworth variety was followed by the Large Black, and this by the Lincoln—sometimes known as the Lincoln Curly Coated pig. It is significant of the tendency of public taste that these breeds should have been established and that the Small White and the Suffolk varieties—both smaller than the Berkshire—should have been practically extinguished. The importance of a large bred sow cannot be over-estimated, for she, rather than the boar, governs the size of the progeny, while as we have seen, size governs early maturity and to a large extent the profit which follows it.

It is here necessary to refer to a practice which is in entire opposition to success in pig breeding and feeding. I refer to the system of selling young and buying store pigs. The pig industry ought not to be expected to bear two profits—the profit of the breeder and the profit of the feeder, still less that of the dealer as well. The greatest success is achieved when the feeder fattens the pigs he has bred. If a feeder is in the habit of buying weaners which another farmer has bred, he may be perfectly certain that the seller has realised a profit on the transaction. That profit he has lost and he has consequently handicapped himself. Looking at the question from the other side, it may be pointed out that if a breeder sells his pigs for somebody else to fatten he forfeits a large proportion of the profit which he would be in a position to make if he had retained and fed them himself. Buyers of stores do not, if they know it, feed their pigs at a loss. The profit they gain should have been the profit of the breeder, and this, added to the profit he has made in the production of his pigs, would make him much better satisfied with his work.

Pig breeding and feeding cannot be compared in this sense with the breeding and feeding of cattle or sheep, for the feeder does not depend upon the crops in his fields. He can keep one or more sows in a very small space, and if he can permit them to graze, so much the better. They farrow in a sty, and there the litter remains, or should remain, until its short career is closed by the knife. Again, the pig-dealer sometimes comes between the seller and the buyer,

and he takes a third of the profit. He visits markets and fairs in the pursuit of his business, buying from some men and selling to others as extensively as he can, although one would suppose that both classes would prefer to complete their transactions themselves. The dealer, too, has frequently been the means of disseminating disease, buying pigs from one market and taking them to another regardless of the fact that they may have been in contact either with diseased stock, or with pigs which have come from infected yards. If a feeder must buy pigs to fatten he would be a much wiser man to buy them direct from some neighbouring farmer and take them home in his cart, thus avoiding the risks which he runs in buying from dealers and which invariably follow the presence of pigs in a market.

Another reason may be advanced why pigs should be fed upon the farm on which they are bred, and not sold for others to feed. From the day of their birth they remain with their dam, learning to feed from her trough, and subsequently before weaning to feed by themselves in a neighbouring sty, from a trough which the dam is unable to reach. This—which is immediately preparatory to fattening—may be regarded as the first stage in the process. There is no variation in the environment of the pigs, which —like all domesticated animals—are influenced by changes that may cause them to lose ground. Young pigs, taken direct from the dam to a new home and fed upon different foods provided by different hands, will not pursue the same even course as if they had remained where they were. They cannot thrive so well away from the only home they have known, when the conditions are so entirely and radically changed. After being sold by their breeder to a new owner they are caught one by one roughly by the leg, thrust into a cart, driven off in an excited state to a dealer's yard, or some miles away to another farmer, where their new life commences. They may or may not suffer that torture of fear which is common to all animals—although in kind hands they will ultimately settle down, enjoy their food, and lay on flesh as if nothing had happened. Yet I venture to express my belief that in no case will they make progress for a number of days. In a visit to the stock-yards of Chicago, where I saw cattle, sheep, and pigs slaughtered in large numbers, I was only too pained to see the most distinct evidence of apprehension and fear upon the face of each. If it pays a man to breed pigs, it should pay him to feed them, combining the two practices and avoiding that process of change of environment which may influence a purchase and add something to its cost. When buying pigs to feed—especially from a dealer or even

in a market—little or no knowledge is obtained as to their breed or capacity for feeding quickly, and while almost all must be taken on trust it is this practice, among one or two others, which has given to pig feeding for profit a bad reputation. The breeder, as distinct from the feeder, is able to be constantly improving his stock, increasing the size of his sows, making a better selection of boars, and thus adding both to the size and the quality of the litters he breeds.

There should be no store-pigs: the system is wrong. Whether pigs are intended for the butcher or the curer, they should be rapidly fed from their birth, first on their dam—for she should supply plenty of milk—and next from the trough. If a young pig is kept upon a store ration for only one week, that week has been lost, for having gained no weight in fat and simply maintained its condition, it has cost money to feed, which, had the food been slightly supplemented and made into a fattening ration, would have been followed by a gain of a pound of live weight per day. Store pigs undoubtedly grow, but mere growth is not fatness nor butchers' meat.

Does the pig pay to feed? Does the pig breeder know what his pigs pay? Does he indeed know whether they pay a profit at all? In my experience the average feeder ignores the one point which is the most important in all business life. He keeps no accounts, and therefore knows nothing about the cost or quantity of the food which is consumed in the sty. Quite apart from the fact that the most capable of agriculturists are business men, I believe it to be true that, so far as pig keeping is concerned, there is no book-keeping system at all. Pig-keepers, however, are not all farmers. It is possible that the majority are compelled to buy all the food which their pigs consume. That food is obtained from a miller or dealer as it is wanted, and no steps are taken to ascertain its feeding value between one purchase and another. If the chief food employed is barley-meal no evidence is forthcoming as to its quality. Barley-meal, which is usually the produce of thin, light, imported barley with a large proportion of husk, is too-frequently adulterated. I have had the opportunity of witnessing the production of cheap barley-meal in a very large mill. To the weak foreign barley was added the sweepings of the floors—this including grain of all kinds and abundance of waste. I am impressed with the belief that where barley is used it should be crushed or kibbled. It is superior to oats as a pig food—only 70 per cent. of which is digestible owing to the large proportion of husk—and superior to maize, which is too starchy for the production of good meat, although 90 per cent. is digested. A feeder can buy his own grain and crush it himself,

selecting a plump sample, not one suitable for malting and sold at a high price, but a sound, heavy barley containing plenty of flour. The reason for the suggestion is that the perfect digestion of grain depends upon its mixture with the saliva, and this particularly applies to animals which do not chew the cud. Sloppy food, like a mixture of fine meal and water, is rapidly swallowed and is not chewed at all. It has been already shown by practical feeders, whose figures I have, that both barley and sharps, which are coarse foods, do excellent work, although the pig feeder in general is wedded too strongly to maize and barley-meal.

It has been pointed out by some scientific men that cooking renders the starch of grain more amenable to the digestive juices which assist in its conversion into sugar, and that it is in consequence more easily appropriated and passed into the blood. Starch is the insoluble carbohydrate—sugar being its soluble representative. As, however, starch must be converted into sugar before it can enter the circulation and nourish the system, it is evident that the more perfectly it comes into contact with the pytalin—which is the principle in the saliva employed for the purpose—the more easily digestion proceeds. As the teeth are supplied to us for chewing food, it appears to me that, both in practice and principle, grain, like barley, should not be ground into meal and subsequently cooked, but should be simply broken or crushed, and then be subject to chewing. Little pigs possess molar teeth which with sloppy food they never use. For what purpose are they given if not to chew their food? It may be well to remark in passing that owing to its insoluble character the starch in farm crops is not washed out by rain in bad weather.

This leads me to a discussion of the results of a feeding experiment made in the summer of 1915 by an amateur who, not being a breeder, purchased his pigs. Eleven pigs were purchased a few weeks after weaning at two guineas apiece. I have been supplied with the names of the breeder and the butcher to whom they were subsequently sold, as well as with the exact quantity of food consumed and its cost, and lastly, with the prices realised and weight of the pigs. Feeding was commenced at once and continued for four calendar months, the foods consumed consisting of potatoes and sharps, and, with the exception of two small quantities of other materials, which were not continued, no other foods were employed. The pigs and their food cost an average of 7d. per day, while the value of the gain made by the pigs, as shown by the price which was subsequently realised, was 13d. per day. In other words, while each animal averaged a weekly return of 7s. 7d. the cost was

only 4s. 1d. A second experiment was made upon the same lines by the same feeder, and again I have been supplied with complete details of the work from first to last. Ten pigs costing £2 apiece were put up to feed upon the two foods previously used—potatoes and sharps—a small quantity (28lbs.) of linseed being supplied during the 18½ weeks which elapsed before the pigs were sold to the butcher. The potatoes, which, like the sharps, were all purchased, cost on an average some 30s. a ton, while the sharps varied from 23s. 6d. to 26s. the bag of 224lbs. The potatoes consumed reached 11,188lbs., so that each pig consumed 8½lbs. per day. On the other hand, the sharps consumed averaged 3·7lbs. per day, costing 1·3d. per pound. The pigs cost the feeder—including the purchased price—6d. and a fraction per pound to produce, whereas they realised 11·3d. per pound. I am, therefore, not surprised at the remark of the breeder that his results should encourage farmers and all others concerned in the pig industry to feed pigs to a greater extent. It has been shown by many feeding experiments that with very young pigs a pound of live weight can be produced from 3½ to 4lbs. of grain. At 1½d. a pound, a ration of 4lbs. a day would cost 6d., whereas the value of a pound of live weight—based on the value of 75 per cent. to represent carcase weight—would at present prices be worth 9d. to 10d., according to the market and the size and quality of the pig. Under such conditions, therefore, pigs would pay at least 50 per cent. upon the cost of production. The actual cost upon the farm, however, depends chiefly upon other conditions. If the pigs are bred by the feeder they cost less than if they are purchased as stores. If the food supplied, as in the experiment to which I have referred, consists chiefly of potatoes—and these non-marketable potatoes—the cost of food is clearly much smaller than where potatoes are purchased. This, too, depends upon the weight of the crop, the nature of the farm, the treatment the crop receives, and the variety of potato planted. In a competition held in my own county three years ago, the winning crop exceeded 21 tons to the acre, as estimated by the judges who weighed a measured area. The second prize exceeded 18 tons to the acre, and this was practically confirmed by the farmer and myself, though in a less elaborate way, by walking across the field—which was an extensive one—measuring a rod and estimating the weight of the potatoes grown upon it from those which were lifted for the purpose. The profit obtained from pig feeding, therefore, is inter dependent upon the production or partial production by the feeder of the food which is consumed.

Having shown, by the figures which have been quoted above,

the profitable character of sharps as a pig food I now turn to an experiment conducted in Ross-shire on a croft connected with the North of Scotland Agricultural College, where the object was to show how small holders can feed pigs profitably. This experiment was carried out before the declaration of war, and consequently the prices are inapplicable to-day. Four pigs were put up to feed in December, 1912, having cost from 12s. 3d. to 17s. 3d. apiece. The foods employed were barley-dust, *crushed-barley*, sharps, skimmed milk, chat-potatoes, and turnips. The average weight of the pigs was 31¾lbs., while during the first month of feeding the food consumed consisted of 13lbs. each of sharps and barley-dust, 43 pints of skimmed milk, with some potatoes and turnips, the quantities of which are not supplied. The average gain during the first month was 27¾lbs. at a cost of 6s. 5¾d. During the second month the pigs consumed 20½lbs. each of sharps and barley-dust, 10lbs. of crushed barley, and 66 pints of skimmed-milk, with potatoes and turnips, the cost being 10s. 6d. The gain made by the pigs was 29¼lbs. In the third month the food consumed consisted of 31lbs. each of barley-dust and sharps, 49lbs. of crushed barley, 47 pints of skimmed-milk, with potatoes and turnips, the cost being 13s. 2¼d., and the gain made 40lbs. In the fourth month the barley-dust and sharps were doubled in quantity, the skimmed-milk was reduced to 16 pints, the crushed barley consumed reached 112lbs., and again potatoes and turnips were supplied, at a total cost of 18s. 9d. The increase in weight reached 33¼lbs. In the fifth month the sharps and barley-dust supplied each weighed 76lbs., the crushed-barley 161lbs., with potatoes and turnips—the increase in weight being 43¾lbs., at a cost of £1 2s. 4¾d. The pigs were sold on the 21st of May at an average of £3 17s. 3d., the entire cost excluding labour having been £6 12s. 3¾d., showing a balance of profit of £8 16s. 8¼d., or £2 4s. 2d. per pig. To quote the report, it appears that in the first month there was a total live weight increase of 110lbs. at a cost of 6s. 5¾d. The increase, therefore, cost less than ¾d. per lb. In the second month the cost of producing a pound of live weight increase was 1·1d.; in the third month, 1d.; in the fourth month 1·7d.; and in the fifth month 1½d. These figures once more demonstrated the truth that the longer a pig is fed the more it costs in the production of each additional pound of live weight. My object in quoting these figures is not to show that the average feeder can produce pork at anything like the cost indicated, but to show that crushed-barley, barley-dust, and sharps, with potatoes and turnips, can be employed in pig-feeding with considerable advantage and in a sense which is quite contrary to general practice and that the

most profitable system of feeding is that to which the holding contributes. The potatoes and turnips were evidently charged against the pigs at nominal prices, although it is not improper to remark that the cost on the farm is almost nominal in normal times. The sharps cost about five-eighth of a penny per pound ; the barley foods were equally cheap ; but, without discussing the immediate cost of production at the present exorbitant prices of food, those who are interested in the question and who carefully study the figures will, after allowing a very wide margin as between the prices charged by the authorities of the North of Scotland College and the prices which they would have to pay for foods under ordinary circumstances, realise that there is still plenty of room for liberal and profitable returns.

In any attempt to answer the question, "Do pigs pay ?" it is evident that we must first ascertain the cost of feeding the sows otherwise we have no means of ascertaining the value of the young pigs when they are weaned and ready for fattening. Some pig-breeders turn out their sows between spring and autumn to graze, simply supplying them with a few handfuls of cereal or pulse grain once or twice daily. This method is undoubtedly a good one where the pig can be prevented from rooting the grass. It is an aid to the maintenance of health, it promotes vitality and prolificacy, and is much superior to the too common practice of keeping a sow in the sty. I am able to employ figures relating to the feeding of sows which will assist us in this discussion. The animals were Berkshires, Cross-breds, and Mongrels. As a group the sows consumed 3½lbs. of mixed grain and 7lbs. of skimmed-milk in a day, and this maintained them in equilibrium, or in other words, they neither gained nor lost weight of any importance. The food actually consumed per 100lbs. of live weight was 1·19lbs. of grain and 2·4lbs. of milk. These figures suggest the importance of a weigh-bridge on the farm. The sows were not all of the same age—varying from one to four years old—the older sows weighing more than the younger and consuming more food. The weight of the Berkshires was 477lbs., 410lbs., and 206lbs., and they consumed an average of 3.6lbs. of dry food per day, although the actual weights of food consumed were 4lbs., 4lbs., and 3lbs., with an average of 7½lbs. of milk. The Cross-bred sows consumed an average of 3·2lbs. of grain ; and the Mongrels 3·2lbs. ; but while the former consumed 7½lbs. of milk the latter consumed 6¼lbs. The Berkshire sows consumed ·95lbs. of grain and 1·9lbs. of the skimmed milk per 100lbs. of live weight ; the Cross-breds 1·16lbs. of grain, and 2½lbs. of milk : and the Mongrels 1·4lbs. of grain and 2·8lbs. of milk. If we assume that the

Mongrel sows consumed in thirty days 30lbs. of grain and 60lbs. of milk per 100lbs. of live weight, it follows that a large sow of 400lbs. would consume 130lbs. of grain and 240lbs. of milk. At the present value of these foods equal to two bushels of maize and 24 gallons of skimmed milk, the cost would amount to 6s. 6d. a week, or very much more money than a sow is supposed to cost to feed in normal times. Indeed, under old conditions, half-a-crown's worth of middlings is all that many persons give to an average sow, in addition to a supply from the garden, a few roots in winter, the waste of a house, or grazing in a paddock.

The cost of a young pig ready for fattening thus depends upon the cost of feeding the sow, to which sum we must add a figure sufficient to cover the risk involved in her life, her purchase price or the interest upon it, the maintenance of the sty, and the labour. It is evident, however, that where a sow produces an average of ten good pigs at a litter, the cost of production is less than when the litter is small; thus we are thrown back upon the general principle that the sow should not only be of a large breed and well-bred, but of a prolific strain, and, what is of enormous importance, able to supply abundance of milk. A litter of pigs may be worth at present prices 20s., 30s., or 35s. apiece, this being largely dependent upon their size and condition when they are ready for feeding; and so it is that in breeding pigs for profit it is imperative that the breeder should be able to judge and select stock of the very best type.

Pig feeders appear to be anxious to feed to great weights, or to weights which are not practical aids to success. In feeding porkers for sale in small lean joints, the work can be completed in half the time occupied in feeding for size and much greater weights. This result, however, while highly desirable, is much less important than the cost. Whereas a porker finished for sale when it has reached a carcase weight of 90 to 100lbs., obtains a much better price by the stone, a pig fed to a carcase weight of 200 to 300lbs. may cost double the money, and this fact is emphasised when the food is all purchased. As the latter weights are reached it will be found, if the food is all weighed, that the daily or weekly gain is worth but little more, and, as feeding proceeds, no more, than the price paid for the food. Pigs fed to small weights, 100lbs. for a porker, and 165lbs. to 175lbs. for a baconer, will return a good profit in capable hands, whereas pigs fed to heavy weights are very uncertain, and at no time pay at an approximately similar rate. It is a much better plan to feed two pigs in succession, each for sixteen weeks, than one pig for 32 weeks. In the former case the

food is less costly, the price obtained is higher, and the feeder has not so long to wait for his money.

I have met numerous breeders and feeders who kill their own pigs and cure their own bacon and hams either for their own consumption or for sale. When farming I was accustomed to do so myself. If this practice were general it would materially affect our imports and encourage the home production of this class of meat. It is a strange fact that British farmers should rely so persistently upon bought foods for their own tables which they ought to provide for themselves. I venture to say that 90 per cent. purchase their bacon, lard, and fresh pork. It is possible for the country to provide food for itself, for, so far as pig products are concerned, we could grow all we require, keep many millions more of money at home, and provide much additional labour.

This leads to my last suggestion. Just as the farmer can cure his own bacon and hams so can the layman. Curing is a process of the greatest simplicity, as I have shown in "The Book of the Pig." The cheapest and best results may be obtained by buying a pig ready killed from a farmer at an agreed price, which should be based on the wholesale market price, by the stone. The head, feet, and internal organs should be delivered with the carcase already cut up for curing by a butcher employed for the purpose. A portion may be pickled for early consumption, and, if necessary, a portion may be sold as a joint. By the adoption of this plan, which involves but little trouble, although it means money earned, the best meat is ensured, and at a much lower cost than if it were bought in the market.

V.—INJURIOUS BRITISH WEEVILS.

By Harold Bastin.

The fact that the name weevil, in its popular usage, has become almost synonymous with "pest," indicates that the damage and loss occasioned by these insects is both obvious and wide-spread. No doubt it is possible to show that much of the destruction for which weevils are often blamed is really wrought by insects of other types. Still, there can be no question that the popular judgment is in the main correct, and that weevils—the name being now used in its restricted scientific sense—are directly responsible for an incalculable amount of injury to man's interests, not only in this country, but in every part of the civilised world. Consider that

not less than 20,000 kinds, or species, are actually known and named; that these all feed exclusively on vegetable substances; and that there is scarcely a part of any plant, or of its products, that is not liable to attack. Does it not seem marvellous that man contrives to wrest food and profit from the soil with such vast forces arrayed against him? But we must remember that the great majority of weevils are confined to tropical and subtropical countries, while of the whole number of recorded species only a relatively small percentage is made up of those which attack cultivated plants. Thus, while in Britain we have about 500 resident species of true weevils, the destructive kinds are not so numerous as to preclude the possibility of dealing with them in the form of an article—our object being to compress into small compass the known facts relative to the life-histories of these pests, and to note the various methods which are adopted for their control.

WEEVILS ARE BEETLES.

It may seem scarcely necessary to point out that a weevil is a beetle. Yet such elementary facts are far too apt to be slurred over or taken for granted; so we will begin by stating briefly what a beetle is, and in what respects weevils differ from the group, or order, of beetles taken as a whole. The most obvious feature of a typical beetle, when contrasted with an insect of another sort, is its thickened fore-wings, which are usually horny in texture, often quite hard and rigid, so that while they have little or no value as organs of flight, they serve admirably to cover and protect both the back of the abdomen and the larger membranous wings which, when not in use, lie folded beneath them.* For this reason the name Coleoptera (from the Greek signifying "sheath-winged") was originally given to the order of beetles; while the fore-wings are commonly spoken of as wing-cases or elytra. Beetles have biting mouth-parts of a character which approaches the more primitive type, such as is seen in a cockroach or a grasshopper. But

* It is an interesting fact that while certain beetles (e.g. the common rose-chaffer) keep their wing-cases tightly folded above the back during flight, others (such as the stag-beetle) hold them out in a more or less horizontal position, in which they appear to afford some support to the body by acting as planes or gliders. In this respect we may term the rose-chaffer a monoplane, and a stag-beetle a biplane, although both insects agree in the number and structure of their wings. Some beetles have the wing-cases fused firmly together along the middle line, so that if the hind-wings are used, they must be slipped out through the narrow cleft at the juncture of the hind-body and the wing-cases. In not a few instances, however, the hind-wings—and of course the power of flight—have become obsolete, the united wing-cases then serving only for the protection of the abdomen.

the details of their development from youth to maturity prove that they are in reality far removed from these relatively simple forms, and must be definitely associated in our minds with what are termed "the higher insects." For beetles undergo a typically complete metamorphosis. That is to say, the newly hatched young is totally unlike its parents in form (usually also in habitat and habits) and when full-fed passes through a quiescent or pupal stage (when it takes no food) ere it reaches sexual maturity.

HOW TO KNOW WEEVILS.

Since the greater includes the less, the above generalized description of beetles applies also to weevils, and in order to distinguish the latter we must go more into details. Weevils belong to a section of the Coleoptera, which used to be known as "Tetramera," because its members appeared to differ from other beetles in possessing only four joints in their feet, or tarsi—the more usual number being five. Subsequent investigation showed that the Tetramera were not really exceptional in this respect, for they were found to have the normal five joints, although the fourth is generally so small that it is apt to escape notice. But the true fourth joint, together with the base of the clawed, terminal joint, lie between the lobes of the third joint, which is always notched at its extremity; while all the three basal joints are more or less deeply cushioned beneath with a velvet-like pile or pubescence. This peculiar type of tarsus is characteristic of the series of beetles called Phytophaga, as well as of the weevils and their immediate allies, which are known as Rhynchophora. But in members of the latter series the third tarsal joint is not merely notched, but noticeably broader than its fellows (Fig. 1); while the insect's head is more or less prolonged in front to form a snout, beak or rostrum, which bears the mouth-parts at its apex.

TRUE WEEVILS OR CURCULIOS.

This series, Rhynchophora, may be separated into four families, viz., *Anthribidæ*, *Brenthidæ*, *Scolytidæ* and *Curculionidæ*. The first of these is sparsely represented in Britain; the second not at all. The third is made up of the interesting but destructive wood- and bark-boring beetles, with which, however, we cannot deal here. To the fourth belong all those numerous species to which the term weevil is most properly applicable. These true weevils are nearly always strongly convex in form, hard as to integument, while the snout or rostrum is generally very evident, and is one

of the chief characters by which members of the family may be recognised. The feelers, or antennæ, which are attached to the sides of the rostrum, are relatively short, and nearly always elbowed, *i.e.*, they have a long basal joint to which a series of lesser joints is attached in such a way that the whole organ can be extended and moved in a manner suggestive of the human arm. The antennal joints vary in number from eight to twelve, while their size is usually increased by a fairly regular gradation from the point of articulation with the basal joint to the tip, the apex of the antenna having thus the appearance of a club.* (Fig. 2.)

THE SNOUT OR ROSTRUM.

The rostra of different weevils vary greatly in length and thickness. Thus, in the leaf-eating weevils (*Phyllobius*), and pea-and-bean weevils (*Sitones*) it is short and stout, whereas in the clover weevils (*Apion*) and the nut weevil (*Balaninus nucum*) it is long and slender. The female nut weevil employs her rostrum to bore holes in green nuts when they are very young, and afterwards inserts an egg in each hole; the apple-blossom weevil (*Anthonomus pomorum*) treats the flower-buds of the apple in like manner; while other species have been observed to make use of their rostra in similar ways. But in some species, we do not know how, or for what purpose, the rostrum is employed—or whether it is used at all; while what office it can serve in the case of the male is difficult to imagine. In many instances the utility of the structure would seem to be considerably hampered by the position of the antennæ, which originate almost at its apex, close to the mouth. In the nut weevil, on the contrary, the antennæ are attached far back, leaving a considerable portion of the rostrum free to act as a boring apparatus. (Fig. 3.)

LIFE-HISTORIES.

The eggs of weevils are usually deposited by the mother, either with or without the assistance of her rostrum, in the midst of the appropriate food—or at least close to it. The typical larva, or grub, has a hard head and powerful jaws, but no true legs. Only in rare instances is it called upon to wander; and should this happen, it progresses by a kind of laborious wriggling, or pulls itself forward by means of its mandibles. These larvæ are not difficult to recognise

* For further information concerning the classification of weevils and their allies the reader is referred to Part II. of "The Cambridge Natural History," by Dr. D. Sharp (Macmillan).

after a few typical examples have been examined. Generally speaking they are fat, cylindrical grubs, white or yellowish in colour, except the head, which is ochreous, reddish-brown or black. The whole body is normally recurved, or sickle-shaped; while in lieu of legs there are certain small tubercles beset with hairs upon the ventral surface. Usually the larva lies actually within the substance of its food or buried in the earth, but in a few cases it feeds openly among foliage. It often leaves its food just prior to its change to the pupal state; and, before this change takes place, it usually constructs a cocoon of one sort or another in which to undergo its transformations. The pupæ of weevils agree with those of all other beetles in being of the type known as "free." That is to say the various appendages of the body are easily separable, and are not all packed closely together under a tough outer crust—as we see in the case of a butterfly's chrysalis. Moreover, the pupa remains soft and pliable. Yet it exhibits little power of movement. (Figs. 4 and 5.)

We may now consider briefly the weevils which in the past have been the cause of loss in this country, taking them in the alphabetical order of their popular names.

APPLE-BLOSSOM WEEVIL (*Anthonomus pomorum*). (Fig. 7–3.) This weevil is widely distributed, being found in France, Germany, Austria and Hungary, and in America, as well as in the British Isles. In England it has proved most troublesome in the southern counties, and is often abundant in the midlands, but does little damage in the north. It is fairly plentiful in Wales and Ireland, but seems to be rare in Scotland. It has been known to attack pear blossom but seldom. The adult insect is about one-quarter of an inch long, generally dark brown in colour, flecked with grey and white pubescence. The legs are of a redder tone than the rest of the body. The most characteristic feature, however, is a pale V-shaped mark on the closed wing-cases. The insects appear during the first warm days of spring, and are said to pair after they reach the trees; but exactly how the branches are gained by the very numerous weevils which hibernate on the ground, under leaves, stones, clods of earth, etc., is a point that has not yet been satisfactorily cleared up. Both sexes have wings, but the females are noticeably tardy in taking to flight. On the other hand, they are rarely seen to creep up the trunks; and both Collinge and Theobald state that they failed to capture a single specimen by grease-banding trees in infested orchards. This, briefly, is how the question stands at the time of writing, although it is clear that the weevils *do* get into the trees—probably by flight during the early hours of the morning, or at dusk.

Egg-laying is a laborious business, each act occupying at least three-quarters of an hour. The female first bores a hole in the selected flower bud with her rostrum, then reverses her position and lays an egg in the hole, and turns round again to push the egg " home " with her rostrum. The whole operation may be observed without difficulty by those who have the necessary patience. The opening in the bud is finally sealed up by a secretion from the weevil's mouth; and, after this has been done, the damage can scarcely be detected, even with the aid of a lens. Dissection has shown that this weevil is capable of depositing between 50 and 60 ova; and we know that the oviposition of a single female may extend over a fortnight at least. But much depends upon the season, for the insect punctures only the tightly folded buds, and, if the weather be fine and warm, the blossom expands so rapidly that few eggs can be laid. Furthermore, it has been shown (1) that the larvæ cannot live in an opened bud, and (2) that they need time after hatching if they are to damage the bud sufficiently to prevent it from opening. It thus happens that in fine, mild weather, when the buds expand rapidly, many young larvæ are destroyed; while in forward seasons many attacked buds open before even the eggs hatch.

"*Capped Buds.*" (Fig. 11.) Attacked buds in an advanced stage are known as "capped buds," because the petals, checked in their growth and wilted, form a kind of cap over the receptacle, or lower part of the flower. In colour they are reddish brown and are often mistaken for buds which have been nipped by white frosts. But an inspection reveals the presence beneath the cap of either the larva or pupa of the weevil; or, at a later stage, a small round hole in the side of the withered flower will be found, marking the perfect insect's place of exit. The larva feeds on the stamens and other internal parts of the bloom and may even consume some of the receptacle; but it rarely touches the ovary. The time necessary for development depends upon the weather, and the larval life may be as short as eight, or as long as twenty-one, days. The pupal state lasts from a week to ten days. The adult beetles spend the summer among the foliage, but whether or not they devour the leaves is another point that remains uncertain. Towards mid-autumn they seek suitable spots for hibernation and remain dormant until the return of spring. In winter they may be found under the rough bark of the trees or beneath stones and rubbish on the ground.

Remedial Measures. This pest could no doubt be dealt with more successfully if its habits were more perfectly known. Grease-banding

may be dismissed as useless, since it is practically certain that the insects do not reach the trees by creeping. Furthermore, unless it can be shown that they habitually devour the leaves, poisonous spray fluids cannot be employed with any degree of confidence, although Theobald says that "it may be possible that some form of arsenate for spraying might poison the beetles while boring the holes for the eggs."*

But, in the present state of our knowledge, the most satisfactory modes of procedure may be tabulated thus :—

(1) Keep the orchard clean. In winter, apply a caustic alkali wash, if necessary, to cleanse the trees from moss and lichen. Scrape off all rough and loose bark. Keep the ground free from clods, stones, and rubbish. The latter, including long grass, should be cleared away and burnt. Collinge mentions that, in the Evesham district, upon turning over a heap of old prunings, he found the heap to be alive with the apple-blossom weevil.†

(2) In spring, be careful to destroy as many as possible of the capped buds. Many fall naturally from the trees, but many more may be brought down by a slight jarring of the branches. They should be swept together and burnt.

(3) At the time of egg-laying, and during the early summer, much good may be done by jarring the branches and catching the beetles as they fall upon boards or cloths smeared with tar or grease. But, as is pointed out in the Board of Agriculture's Leaflet, No. 15, the fruit-growers of a district should combine to wage war in this fashion simultaneously and with care and energy.

BLACK VINE WEEVIL (*Otiorhynchus sulcatus*). (Fig. 6–1.) This is one of several nearly related weevils which attack a large variety of cultivated plants growing in the open and often prove troublesome in greenhouses. The popular name of the present species is somewhat misleading, for, while it is liable to infest vines and seems in this country more harmful under glass than in the open, it also attacks raspberries, strawberries, and many other plants and has been also found on the hop. Like its congeners, it is wingless and creeps up the stems at night, hiding by day in crevices or under clods or stones. The term "*sulcatus*" refers to the exceptionally broad, deep furrow

* "Insect Pests of Fruit," (F. V. Theobald). Published by the Author.

† "A Manual of Injurious Insects," (W. E. Collinge). Midland Educational Co., Ltd.

on its rostrum. The whole body, including the legs, is black, while the antennæ are brown. There are a few greyish lines on the head and thorax and a few isolated patches of yellowish hairs on the wing-cases. Its size is variable, but an average specimen measures about seven-sixteenths of an inch from the tip of the extended rostrum to the end of the abdomen.

The eggs are laid in or at the surface of the soil during the summer, and the grubs may be found throughout the winter in the earth feeding upon the roots of plants. They change to pupæ in the spring —spinning no cocoons, but lying in little chambers of the bare soil at a depth of from two to four inches below the surface. The pupal stage continues for some fourteen days. Both larva and pupa are yellowish or creamy white in colour and are somewhat hairy.

Tarred Boards and Cloths. The black vine weevil, like the other species commonly found in gardens, readily falls to the ground and "feigns death" when alarmed. This habit should be taken advantage of in our efforts to check the ravages of the pest; for if freshly tarred boards or cloths are spread carefully at night under the infested plants, a little tapping or shaking of the branches will suffice to make captives of practically all the weevils that may be feeding thereon. When conducting these operations, however, it is very necessary to proceed with caution, since one careless flash of the lantern, or an untimely shake, may result in the loss of hundreds of the marauders. Theobald advises that after treating raspberry canes in the manner indicated above, the soil round them should be gone over with the prong-hoe next day, and that a top dressing of ashes and carbolic acid should be used—one pint of carbolic acid to a bushel of ashes being the proportions suggested. By percolating through the soil the carbolic acid may be expected to affect the larvæ, at least to some extent; but they are reached most effectively by the use of bisulphide of carbon, or some well-tested proprietary soil-fumigant, such as Strawson's "Vaporite," which is safe to handle and much cheaper than the bisulphide.

Bisulphide of Carbon. If bisulphide is employed, it may be most easily and quickly injected into the soil by means of one of the special instruments sold for the purpose. For raspberries, Theobald recommends the use of half an ounce of chemical for each plant; but more or less may be necessary according to the circumstances of each case. Several small injections should be made at various points round each plant. The best depth for injection has not yet been definitely determined; but it is well to remember that the heavy fumes tend to sink downwards through the soil, and that

while these are quite harmless to root tissue, the chemical itself damages roots with which it comes into contact. Also, when using bisulphide of carbon, never forget that its fumes are both poisonous and very inflammable.

As these weevils pass the winter in the larval state, they will not be inconvenienced by the removal of rubbish, etc., such as would provide hibernating quarters for many other insects; but since they seek shelter beneath which to deposit their eggs, all weeds, refuse, etc., should be kept away from plants that are liable to attack; and in the case of strawberries the straw or grass which is used to keep the fruit off the ground should be put on as late as possible and removed as soon as practicable. Dressings of lime and soot, or of ashes or sawdust saturated with paraffin, would tend to prevent egg-laying; and Theobald recommends that one such dressing should be applied in autumn and another in March, as a general precaution against these pests. Infested strawberry beds should be gone over in the autumn, the larvæ being picked out of the roots as far as possible. In the field, when infested crops are grubbed up, the land should not be planted again with strawberries for several years.

BLOSSOM WEEVIL (*Anthonomus rubi*). (Fig. 8–3.) This tiny insect—it is only about one-eighth of an inch long—destroys the blossom buds of strawberries, raspberries, and loganberries, and attacks the folial shoots and younger leaves. It's life-history has been worked out by Fenoulhet, and is summarised by Theobald in his book "The Insect Pests of Fruit." This weevil is found upon brambles and wild roses, as well as upon the cultivated plants named above. The perfect insect is closely related to the apple-blossom weevil, and, like it, has a long, curved rostrum; but its colour is uniform black, with a scanty grey pubescence, evenly distributed. The weevil appears first in May and lays its eggs in closed blossom-buds—one egg in each. After each act of oviposition, the female punctures the flower stalk with her rostrum, and this causes the bud to wilt and shrivel. Many of the attacked buds fall from the plants. The grub, which hatches from the egg in from four to six days, feeds within the blossom-bud for about three weeks, then changes to a pupa, in which state it remains for about seven or eight days. Besides the loss in the yield of fruit due to the activities of the egg-laying females in the spring-time, much damage is done, both then and later in the year, by the weevils puncturing the delicate leaves and stems in order to suck the sap. This continues practically until the autumn, when the insect goes into winter quarters similar to those which the apple-blossom weevil affects.

Fig. 1.—Characteristic tarsus of a Weevil.

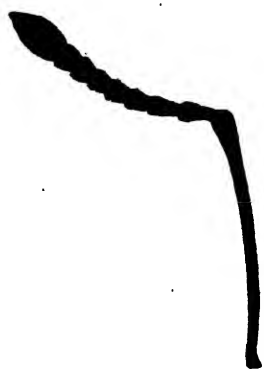


Fig. 2.—Characteristic antenna of a Weevil.

Fig. 3. The Nut Weevil (*Balaninus nucum*). Note the long snout or rostrum. (Magnified).

Fig. 4. Larva and pupa of *Otiorhynchus picipes*. (Magnified). (N.B. - The wing flaps of the pupa are normally pressed closely to the sides of the body).

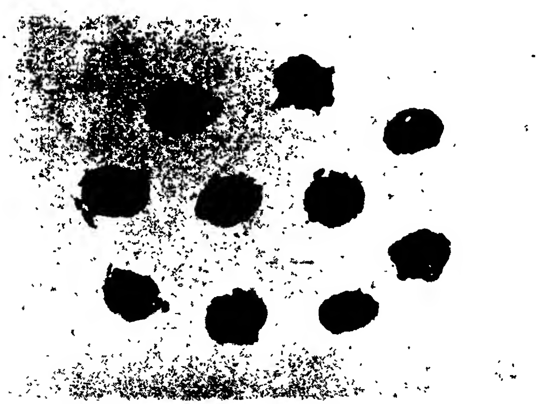


Fig. 5. - Earthen cocoons of *Ceutorhynchus sulcatus*. (Magnified).

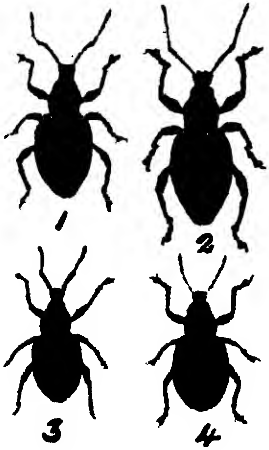


Fig. 6.

1. *Otiorhynchus sulcatus.*
2. *O. tenebricosus.*
3.—*O. picipes.*
4. *Liophlœus nubilis.*

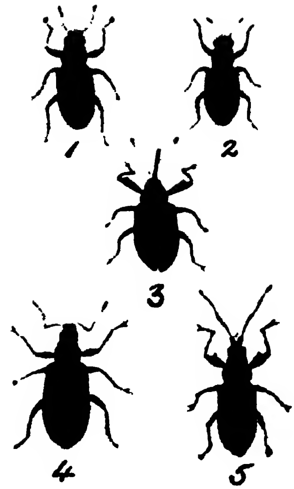


Fig. 7.

1. *Sitones lineatus.*
2. *S. crinitus.*
3. *Anthonomus pomorum.*
4. *Phyllobius maculicornis.*
5. *P. oblongus.*

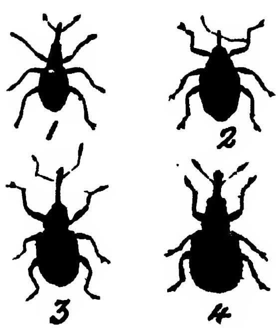


Fig. 8.

1.—*Apion apricans.*
2.—*Ceutorhynchus sulcicollis.*
3.—*Anthonomus rubi.*
4.—*Rhynchites cœruleus.*

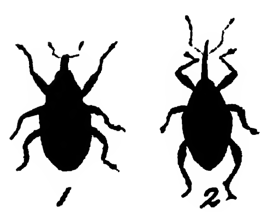


Fig. 9.

1.—*Cryptorhynchus lapathi.*
2.—*Balaninus nucum.*
(All magnified).

Arrow indicates point at which egg was laid.

Fig. 10. Damage to oak leaf by *Orchestes quercus*.
Inset : The insect (magnified).

Fig. 11.—"Capped" apple blossom buds—the injury is done by larvæ of *Anthonomus pomorum*.

Clear away all Rubbish. The increase of this, and of many other destructive pests, might be effectually checked if gardeners and others were more careful in the disposal of their refuse. Moreover, as far as practicable every possible hiding- and breeding-place of pests should be demolished. It is false economy to retain old wooden fences and dilapidated buildings, since they afford innumerable chinks and crevices wherein insects of many kinds pass the winter—as also do piles of pea and bean sticks, stacks of turf, and neglected brickwork from which the mortar has crumbled away. Heaps of soil, rotting leaves and manure (unless previously treated to destroy insect life) should not be allowed to lie indefinitely in odd corners; while worthless rubbish of all kinds should be burnt without delay. Apart from such precautions as these, which are equally applicable to many other pests, little can be done to frustrate the blossom weevil. The adult insects may be shaken periodically from raspberry bushes and captured on tarred boards and cloths; but this method is obviously impraticable in the case of strawberries.

CABBAGE-STEM WEEVIL (*Baris* [*Baridius*] *chloris*). In her "Report" for the year 1892 (pp. 23–26), Miss Ormerod refers to this insect as having done much harm to the stems of cabbage in Co. Wexford, Ireland; but, with the exception of a doubtful case in Essex, in the same year, there seems to be no other record of damage done by this species in Britain, although it is well known as a crop pest on the Continent. The weevil is slightly less than one-sixteenth of an inch in length, including the rostrum. Its colour is shining green, sometimes bluish green. The eggs are said to be laid in the axils of the leaves, or it may be in the stems, of various kinds of cabbage. After hatching, the grubs gnaw their way into the stems and side branches, which "are for the most part entirely eaten out, and filled with crumbly matter." Pupation takes place in the stems, usually during July, and many of the beetles lie up in the stems throughout the winter, while others emerge and hibernate among rubbish, or in some other suitable shelter. As nearly full-grown grubs have been found very early in the season, it is thought that many of the weevils may oviposit in winter cabbage. Should this insect appear as a pest in any locality, the careful drawing and burning of infested plants would probably serve to stamp it out.

CABBAGE AND TURNIP WEEVIL (*Ceutorhynchus sulcicollis*). (Fig. 8–2) This species is also known as the "turnip gall weevil." It is a small, black, convex insect, with a long, curved rostrum. It injures various kinds of turnips and cabbages by laying its eggs in the roots

or the underground part of the stems—the female insect boring holes with her rostrum and depositing one egg in each. In consequence of the irritation thus set up, and of the subsequent activities of the larva feeding in the plant tissues, nipple-like lumps or warty excresences are formed. These are known as "galls." In each the larva occupies a central position, lying in a little chamber. Here it feeds on the sap and the soft tissues around it, and in some instances remains in its snug quarters throughout the winter. But many of the larvæ leave the galls in the autumn; and all, when they reach the soil, construct cocoons of small earth grains worked up with a viscid, silk-like substance which sets hard soon after exposure to the air. These cocoons are scarcely distinguishable from the nodules of earth among which they lie. (Fig. 5.)

Club Root or "Finger-and-Toe" Disease. This weevil is not capable of much direct injury, although when very numerous it may so much spoil the appearance of turnips as to render them unfit for marketing. But there can be no doubt that rapid decay of the roots is sometimes due to moisture and microscopic organisms gaining access to the cavities of the galls after the grubs have vacated them. Moreover, these galls are frequently found in connection with the fungoid disease known as club root or "finger-and-toe." The two attacks are quite distinct, the latter being due to the presence of a slime-fungus (*Plasmodiophora brassicæ*) in the soil; but it is possible that the holes left in the galls by the grubs may afford places of entry for the fungus into the root tissue.

There are probably two generations of the cabbage and turnip weevil each season. Dressings of lime help to prevent the attacks of both fungus and weevil. Gas-lime and wood-ash are also good preventives, while marl or fresh soil has been found useful in old garden ground. Deep trenching, which throws fresh soil to the top and buries the cocoons so deeply that the weevils, when they emerge, are unable to come to the surface, is also recommended. Moreover, a change of crop to some plant not of the cruciferous sort is advisable. Much may be done towards checking the increase of this weevil by burning infested cabbage stalks instead of allowing them to rot in heaps, or burying them under a shallow covering of soil. Charlock and all cruciferous weeds should also be destroyed, as if left to flourish they act as nurseries for the pest. This remark applies also to many other injurious insects, which are able to subsist quite well upon common wild plants. For example, the bean-aphis, or "collier" occurs upon dock, the celery-fly infests certain thistles and other weeds, while the raspberry beetle and blossom weevil both breed on brambles. Indeed, the only safe rule in this

matter is ruthlessly to destroy all kinds of wild grasses and weeds in the neighbourhood of cultivated ground.

CLAY-COLOURED WEEVIL (*Otiorhynchus picipes*). (Fig. 6–3.) In most districts this is the commonest of those weevils which do so much damage to plants, both in gardens and greenhouses, by puncturing the young shoots, and (as larvæ), by feeding upon the roots. It is known also as the raspberry weevil, because it is especially liable to attack the tender shoots of raspberry canes. The most serious outbreak of this pest on record is described by Miss Ormerod.* It occurred in 1878, and the following year in Cornwall, when the loss of many hundreds of pounds was occasioned in the fruit gardens of Madron and Gulval alone. It has frequently been observed that if this pest is numerous one year, it appears in equal or greater numbers the next year, and so on from year to year unless measures for its suppression are put into force.

As its popular name suggests, *O. picipes* resembles a clayey soil in colour; and when it falls from the bushes and "feigns death" upon the ground it is scarcely to be distinguished from a nodule of soil. Its colouring is due to a thick covering of hairs and scales, the actual surface of the body being blackish. The legs are reddish-brown. In size, this weevil varies from one-quarter to almost one-third of an inch in length. Its life-history and habits agree closely with those of the black vine weevil (*q. v.*), while the preventive and remedial measures which may be put into force are the same for both species. With regard to experiments recently conducted with a view to finding remedies against the clay-coloured weevil, Collinge says:—"The most effective remedy was found in placing overnight amongst the branches bundles of loosely twisted hay, made up into rope-like pieces. When removed in the morning, these were found each to contain two or three dozen beetles. The bundles should be immediately burned on being removed." This, of course, refers to attacks in the open; but the same authority remarks that "in conservatories and greenhouses a few toads will prove very valuable in destroying this and other pests." The reader may be reminded that this weevil is one of those that are known to be carried off by certain of the solitary wasps as provision for their nests. It is also eaten by blackbirds and thrushes.

CLOVER WEEVILS (*Apions sps.*). (Fig. 8–1.) The genus *Apion* includes numerous tiny, more or less pear-shaped weevils, which chiefly frequent clovers, trefoils and allied plants. Several species have

---

***"Handbook of Orchard and Bush Fruit Insects." (E. A. Ormerod). Simpkin, Marshall. 1898.**

proved very injurious to cultivated clovers. The perfect insects feed upon the soft tissues of the leaves, while the larvæ destroy the seeds. The chief offenders appear to be three in number, but they are all very similar and not readily distinguishable by the novice. *Apion apricans* is especially injurious to the cultivated red clover (*Trifolium pratense*). The eggs are laid in the flower-heads, where the minute larvæ pierce the calyces and devour the developing seeds. When full-fed, each changes to a pupa in the flower-head and is transformed into the perfect insect in about twelve days. There are at least two, probably more, generations of this pest in the course of the season. Attacked florets turn brown and wither prematurely. Thus the presence, in a crop of full-flowered clover-heads, of certain florets which have failed, is a sign of infestation. If an attacked floret is carefully pulled out, the minute hole made by the larva in the calyx may readily be distinguished by the aid of a lens; and, perhaps, the larva itself may be found within in the very act of devouring the seed. A closely allied weevil is *A. assimile*, which attacks red clover and other species of *Trifolium* in a similar manner. Dutch or white clover (*T. repens*) is especially liable to suffer from the depredations of a third species, viz., *A. flavipes* — often referred to as the "yellow-legged weevil," although, in fact, its legs are scarcely more noticeably yellow than those of the two other species.

There can be no doubt that cultivated clovers are liable to suffer from the attacks of other species of *Apion*; but the three which have been named are the most common offenders, and their habits may be regarded as typical of the genus. The losses which they impose upon the agriculturist are often serious. Suggested remedies include the early cutting or feeding off of suspected crops; the cutting of badly infested clover before it ripens, and runs to seed; and strict rotation of crops—clovers not being allowed to remain more than two years in succession on the same ground. At present we know of no practical method for destroying these tiny weevils when they appear on the plants; hence, our object must be to prevent them breeding.

FIGWORT WEEVILS (*Cionus scruphulariæ and C. hortulanus*). (Fig. 12.) Collinge reports a case in which the larvæ of *C. scrophulariæ*, whose customary food-plants are the figworts, were found upon mangel and beet, to the leaves of which they did considerable damage. "Whether or not (he remarks) this insect will forsake its original food plant for those of cultivated plants remains to be seen. It frequently happens that such is the case and in the change of a food-habit of this kind, it is doubly important that those

individuals that migrate from the knotted figwort to the beet and mangel should be exterminated. This, I believe, has been done in the present case." *C. scrophulariæ* appears to be widely distributed in the United Kingdom and is undoubtedly very prolific. It frequently occurs in company with the very similar, but paler-coloured, species, known as *C. hortulanus*, of which, indeed, it may be no more than a variety. The life-histories of the two forms appear to be identical. The larvæ, which are covered with a glutinous secretion, are somewhat slug-like in appearance and feed openly upon the soft parenchyma of the leaves, but do not touch the ribs and stems. Before changing to the pupa, the larva fixes itself and forms a spherical cocoon, which seems to consist of thickened layers of the glutinous matter already referred to. Many writers state that these cocoons are usually fixed to the leaves on the under-side; but it is certain that a large percentage are to be found among the dried seed-capsules of the figwort, to which they bear a close resemblance both in form and colour. The pupal stage lasts for six or eight days, after which the perfect insect cuts a neat round hole in the cocoon and so escapes. Even when present in considerable numbers, these weevils are easily overlooked by the novice because of their sluggish habits and of their curious resemblance to bird-droppings.

Collinge points out that in the event of these figwort weevils becoming a pest their wild food-plants—*i.e.*, the figworts, and, possibly, other *Scrophulariaceæ*—would have to be destroyed; also hedge-side débris, etc., in which, presumably, the perfect beetles find harbourage during the winter. He also suggests the scattering of lime and soot, or kainit, on the surface of the ground under infested plants, as both larvæ and perfect insects fall readily from the leaves when alarmed.

FILBERT WEEVIL (*Balaninus nucum*). (Figs. 3 and 9–2.) The genus *Balaninus* is represented in Britain by about eight species, remarkable for their very long rostra and the fact that they deposit their eggs in the substance of nuts, kernels and galls. The only species that has so far proved of economic importance in this country is the filbert weevil (*B. nucum*), which attacks filberts and cobs as well as wild hazel nuts. As Theobald remarks, "the damage is done by the maggots feeding in the kernel and causing the nuts to fall prematurely, and also by spoiling the samples owing to the repulsive appearance of the magget found on cracking the nuts." The novice will find the filbert weevil very difficult to distinguish from several other long-snouted, tawny-brown *Balanini*; but its presence upon the nut bushes should serve to set at rest any doubt as to its identity.

It first appears about mid-June, or earlier, and feeds upon the leaves, from which it falls to the ground if the bushes are shaken. Both sexes may also be seen on the wing, especially in warm, bright weather. The female's method of oviposition has already been described. The egg hatches in about eight or ten days, and the larva feeds on the kernel, which it tunnels or grooves out on one side. When mature, it effects its escape from the nut by boring a small round hole in the hard shell. (Fig. 14.) It then allows itself to fall to the ground, into which it burrows. It remains in the soil throughout the winter and changes to a pupa in the early spring. To ward off an attack of this insect, the soil round the bushes should be well worked up during the winter. This will destroy many of the grubs and expose others to birds, by which they are greatly relished. The adult beetles may be shaken from the bushes on to freshly tarred boards or cloths; while in bad cases spraying with arsenate of lead is recommended.

GRAIN WEEVILS (*Calandra granaria and C. oryzæ*). (Fig. 17.) These two weevils are very destructive to stored grain—and, indeed, to stored seeds of many kinds, as the present writer has proved by experiment during the past five or six years. They have frequently caused very serious havoc in mills, stores and granaries, and on board ship. Cargoes of grain and rice which have been carried long distances sometimes arrive swarming with these pests, and the loss occasioned during the voyage may amount to thousands of pounds sterling. Of the two species, the larger is the corn weevil (*C. granaria*), which may also be distinguished by its uniform brownish-black colouring and by the fact that the pittings or punctures which mark the surface of its thorax are oblong. Furthermore, this species has no functional wings. On the other hand, the so-called rice weevil (*C. oryzæ*) has well-developed flying wings, while each elytron, or wing-cover, usually bears two conspicuous, orange-coloured patches, and the thoracic punctures are rounder and more closely set than in *C. granaria*. Harm is done both by the adult beetles and the grubs, the whole life-history being passed through among the infested grain. The female lays one egg in each grain, upon the contents of which the larva feeds and within which it subsequently changes to a pupa. Cole's experiments have shown that moisture in the form of water-vapour is very favourable to the increase of these weevils and that they develop best in a temperature of 80° Fahr.* Infested grain may be "spouted," *i.e.*, run down a long sieve with

---

* "The Bionomics of Grain Weevils," (F. J. Cole). The "Journal of Economic Biology," 1906, Vol. I., Part 2.

holes large enough for the beetles to drop through ; but small enough to allow the grains to pass over. This plan, however, does not affect grains that contain eggs or developing larvæ. Fumigation with bisulphide of carbon is probably the surest remedy, while cleanliness and thorough ventilation in granaries and ships are important preventive measures. In favourable circumstances these weevils multiply prodigiously, generation succeeding generation apparently without pause, until some change in the environment imposes a check. The contents of the grains are industriously fed upon by successive tenants until only the outer husks remain. The following passage from Cole's paper deserves special note: "In experimenting with grain weevils, it is important to remember that no animal shams death more successfully, or keeps it up for a longer time than these small insects. Much of my earlier work had to be repeated owing to my failure to realize this."

HOP WEEVIL (*Liophlœus nubilus*). (Fig. 6–4.) Like the clay-coloured and black weevils, the present species is liable to attack the hop, although in most seasons it is probably too scarce to work serious injury. It varies in size considerably—from one-third to three-fifths of an inch—female specimens being larger than male, on the average. The general ground colour is blackish, with a fairly dense covering of greyish-brown hairs and scales, the arrangement of which upon the wing-cases produces a somewhat tesselated effect, with darker longitudinal lines. The hop weevil normally frequents hedges, where it lives on various young trees, ivy, etc., puncturing the tender shoots in order to suck the sap. Like members of the genus *Otiorhynchus* it is nocturnal in its habits, and wingless. Apparently no observations of its life-history have yet been made.

LEAF-EATING WEEVILS (*Phyllobius sps*). (Fig. 7–4 and 5.) The genus *Phyllobius* includes a number of species which often do considerable damage to the foliage of trees and shrubs. When in fresh condition, most of them may be recognised by their covering of brilliant scales—green, purple, golden or coppery in colour, according to the species. One (*P. argentatus*) is known as the "British diamond-beetle," and is in request as an object for the microscope. Probably *P. pyri* is the most harmful forest species. It may sometimes be found, literally by millions, upon young oaks and other trees, which in a short time are quite defoliated by the pest. Gillanders records a case of young planted trees of ash and birch being thus treated by another species, viz., *P. maculicornis*.* This is the so-called "green-leaf weevil" which, together with the "oblong weevil" (*P. oblongus*), may be

---

* "Forest Entomology," (A. T. Gillanders). Blackwood & Sons. 1908.

classed as the two chief offenders in the orchard, although instances of more or less serious damage by other species are on record. *P. maculicornis* has a brownish ground-colour which is entirely hidden in freshly emerged specimens by a dense covering of shiny, golden-green scales. These scales are easily rubbed off, however, and older specimens of the weevil are often almost completely denuded. *P. oblongus*, which is also known as the "brown leaf weevil," lacks the characteristic shining scales, and is somewhat variable in colour; but in general the head and thorax may be described as dark, even black, and the wing-cases, legs and antennæ as reddish- or yellowish-brown. These weevils cause damage by nibbling the young buds, as well as by eating the older leaves. They are destructive throughout May and June, and are especially active on warm, bright days; but Theobald has pointed out that in certain years they appear to do little harm, although occurring in great numbers.

The life-histories of these weevils have not yet been fully investigated. But it is known that the eggs are laid in the ground, and that the larvæ feed throughout the winter on roots of various kinds—though there are no records of serious damage due to their activities. They change to pupæ in spring, and the perfect insects begin to appear in May. On dull days, when the weevils are inactive, they can easily be shaken off the branches and caught on tarred boards or cloths—as is done with the clay-coloured and allied weevils. Theobald has found that arsenate of lead spray-fluid, used to destroy caterpillars, killed these beetles also. He further tells us that "when young grafted stock is affected, it has been found of use to tie grease bands around them and to then jar the beetles off, numbers when crawling back being caught." In this connection, however, it seems necessary to remind the reader that these weevils are winged, and that they fly actively in sunny weather.

LEAF-MINING WEEVILS (*Orchestes sps.*). (Fig. 10.) These are small weevils whose larvæ mine in the leaves of different trees, eating the parenchyma but leaving the upper and lower skins intact. The perfect insects, which have the habit of jumping, carry the rostrum in repose bent back on the under surface of the body. They eat holes in the leaves, and when very numerous give the foliage a characteristic, shot-riddled appearance. The life-history of the oak-leaf miner (*Orchestes quercus*) may be regarded as typical. The adult beetle hibernates under fallen leaves and in crevices of the bark and appears in spring simultaneously with the bursting of the leaves. The female deposits her eggs singly in the mid-ribs of expanded leaves, usually half way down. When the larva hatches, it burrows towards the edge of the leaf, where it continues to feed, eventually

giving rise to a large, blister-like patch. When the pest is present in large numbers, a yellowish tinge may be imparted to the body of the foliage. The full-fed larva spins a slight cocoon within the leaf, and changes to the pupa. The perfect insect appears in about fourteen days. A smaller, dark-coloured species (*O. fagi*) attacks beech leaves in a similar fashion and is often very destructive to the foliage. The injury done by both these insects is sometimes attributed to late spring frosts ; but frosts usually shrivel up the entire leaf-substance, whereas the injury caused by the beetle only affects a part. Up to the present, no practical method for dealing with these insects has been suggested ; but the question certainly calls for expert consideration, more especially since the unprecedented demand for wood, consequent upon the war, has caused many thousands of acres in this country to be stripped of their timber. When re-afforestation is seriously taken in hand—as we may hope that it will be at no distant date—the presence of insect pests must not be overlooked.

OSIER WEEVIL (*Cryptorynchus lapathi*). (Fig. 9–1.) This rather large weevil, the only British representative of its genus, attacks alders, willows, poplars, and birches, of which it eats the bark and sapwood of young shoots. Moreover, serious damage is sometimes done by the larvæ, which burrow in the stems, penetrate into the pith, and occasionally cause such injury that the stems break off or die. (Fig. 16.) Alder is more often attacked than the other trees mentioned, and young trees from four to six years old are most likely to suffer. The female lays her eggs singly in holes which she bites in the rind. The grub, which hatches in from 18 to 21 days, burrows and feeds in the stem during the summer, and changes to the pupa in August, having first formed an opening through the bark for the exit of the perfect insect, which appears in the autumn, and hibernates either in the chambers formed by the larvæ, or among rubbish and moss. Cutting down and burning infested shoots will obviously tend to check the increase of this weevil, as will also the destruction of all refuse—such as peel, chips and dead leaves—in the vicinity of osier beds.

PEA AND BEAN WEEVILS (*Sitones sps.*). (Fig. 7–1 and 2.) These weevils feed on the leaves of peas, beans, clovers, and allied plants, and are very injurious, especially to seedlings. There are several species, but the two that have proved most harmful to cultivated crops are *S. lineatus* and *S. crinitus*. The former, which is the commonest, usually has three distinct dark grey lines on the thorax, and many longitudinal lines on the wing cases ; but some specimens are unicolorous. *S. crinitus* is smaller, of a grey or reddish colour, with more or less

distinct dark patches on the wing-cases. Other specially injurious species are *S. hispidulus*, which is characteristic of sandy districts, and *S. humeralis*, which is common on trefoil in the south of England. The life-histories of all these weevils appear to be similar in essential particulars. The females lay their eggs either upon or just under the soil, close to the roots of plants, upon which the grubs feed. When full-fed, each grub changes to a pupa in an earthen cell, which it constructs about two inches below the surface. The adult beetles hibernate in ricks, stubble, hedgerows and other places where dry shelter is available. In spring they attack the young plants as soon as these appear above ground and lay the first batches of eggs, there being two broods of these pests in the course of the season. The ravages of *Sitones* may be recognised by the semi-circular character of the cuts made in the leaves, as distinguished from the irregular mutilations caused by sparrows, slugs, caterpillars, etc. Lime and soot, either separately or in combination, may with advantage be sprinkled over infested plants while the dew is upon them, or after rain. When peas and beans are attacked, it is desirable to break up rough clods and press the soil down firmly close round the plants. This destroys the beetles' hiding-places, and makes it difficult for them to come up from the earth. In gardens, spraying with arsenical washes has also been found beneficial. All stubble, weeds, and rubbish should be burnt, while approved insecticides may be dug into the soil after an attack. In the Board of Agriculture's Leaflet, No. 19, which deals with these weevils, the following passage deserves special notice: "The burning of stubble, weeds, roots and rubbish is but seldom practised in these days, and it is believed that the infrequency of this practice is one cause of the more numerous and more destructive visitations of insects injurious to crops."

PINE WEEVILS (*Hylobius* and *Pissodes*). (Fig. 13.) Among the most serious forest pests are several species of weevils which attack pine trees of various kinds. The large brown pine weevil (*Hylobius abietis*), which is said to be the worst culprit of all, destroys large numbers of young Coniferæ, acres of which have to be re-planted because of this insect's attacks. The larvæ, or grubs, live in the stumps and roots of dead or felled trees, and therefore do little or no harm; but the adult beetles gnaw the bark off the stems of young plants and the younger shoots of older ones. The females lay their eggs singly in or near the stumps or thicker roots, and the grubs form long tunnels between the wood and the bark, often working their way along quite thin rootlets. When full grown, the grub scoops out a depression in the wood and changes to a pupa beneath a covering

of dust and wood chips. The pupal stage lasts for about three weeks, and the chief period of emergence is in May and June—when the bulk of the eggs are laid. But the perfect insects continue to appear, and breeding takes place, right up to September. As a result, much overlapping of generations is occasioned, and it is possible to find this species in all its stages at one and the same time during any month of the year. Furthermore, it has been shown by Von Oppen that the adult can persist during one season, and then, after hibernating, can proceed anew to pairing and egg-laying. Among the numerous preventive and remedial measures that have been suggested for coping with this serious pest is the removal from felled areas in pine woods of old stumps and roots, so as to deprive the insects of their breeding places. The adult beetles may also be trapped in enormous numbers by laying here and there on the ground pieces of fresh Scotch pine bark. The beetles collect under the bark to feed, and may be readily destroyed. Such traps must be regularly visited and periodically renewed.

BANDED PINE WEEVIL (*Pissodes notatus*). Besides *Hylobius*, there are two or three closely allied but smaller species, which seem to be especially injurious to the Scotch pine (*Pinus sylvestris*), although other conifers are attacked by them. These belong to the genus *Pissodes*—of which the species called *P. notatus* is the most frequent cause of trouble. The adult beetles, when feeding, pierce the bark with their rostra right into the cambium and the innermost layers of the wood. The eggs are laid in punctures made in the bark, between which and the wood the larvæ tunnel. When full-fed each larva gnaws out a bed in the outer wood at the end of its gallery, and protected by a covering—or cocoon—of dust and wood chips, changes to the pupa. When ready to escape, the weevil bores a neat circular hole through the bark. This insect is injurious both in its larval and perfect states, since young-planted pines are frequently selected by the females for the purpose of oviposition. In cases where these pests have not obtained a footing, a timely rooting up of all suspected or sickly trees will go far to prevent injurious attacks. When the weevils are present in numbers they may be captured by means of "catch-trees" or "decoy-stems," which consist of sickly plants or trees purposely left here and there in the nursery or plantation; for there is reason for suspecting that these pine weevils lay their eggs by preference in trees that are already on the down grade. Like *Hylobius*, these smaller weevils may also be trapped under bark with good results.

RED-LEGGED WEEVIL (*Otiorhynchus tenebricosus*). (Fig. 6–2.) This is the third of the three common *Otiorhynchi* whose depredations in

gardens and greenhouses have already been referred to. The present species is supposed to be especially harmful to the plum, and is known as the "plum weevil" in some districts; but it attacks many other plants as well and is very common in the south and south-east of England, especially on chalky soils. Theobald states, however, that he has no record of its having attacked raspberries outside the county of Kent. It may be known by its dull red legs and black, shiny body. Its length is usually about half an inch, but much smaller specimens are not uncommon. In its life-history, *O. tenebricosus* differs in no important respect from the other common species of the genus, while the same methods of suppression are applicable in each case. The red-legged weevil is closely related to another species—*O. fuscipes*—which is also injurious, but less common.

SMALL STRAWBERRY FRUIT WEEVIL (*Exomias araneiformis*). Fowler* mentions this small weevil as an occasional pest, and Theobald reports it as having done much damage to maturing strawberries at East Peckham, Kent, in 1908. It burrows into the fruit, both green and ripe, but whereas in the former case irregular patches over the surface are eaten away, in the latter characteristic cavities are formed, within which the insect may be found feeding at dusk and in the early morning. The weevil is about one-quarter of an inch in length, black or deep shining brown in colour, and is clothed with a scanty grey pubescence. Its legs are reddish. As a pest, it is at present confined to the south of England, and is especially common in the south-east. Its life-history does not appear to have been investigated and too little is known of its habits to suggest means for its suppression. Theobald, however, has found that it will congregate under damp bark and moss, and suggests that in case of future attack it might easily be trapped.

TURNIP-SEED WEEVIL (*Ceutorhynchus assimile*). This species is closely related to the cabbage and turnip weevil, which it resembles in appearance. It does not produce galls, however, but lays its eggs on the pods, into which the larvæ burrow and destroy the seeds. Attacked pods contain few, if any, perfect seeds. A check might be put upon the increase of this destructive pest if infested seed were fumigated with bisulphide of carbon; and all wild cruciferous plants which the insect is liable to attack should be kept down.

TWIG-CUTTING WEEVIL (*Rhynchites cœruleus*). (Fig. 8–4.) This diminutive weevil—its length, including the rostrum, is rarely much

---

* "The Coleoptera of the British Isles," (Canon Fowler). Vol. V., p. 1,191.

more than one-eighth of an inch—is one of a genus remarkable for the leaf-rolling and twig-cutting activities of the females when discharging their parental duties. It is seen first in spring, and may be looked for upon apple trees and bushes. The habits of the female have been described by Theobald as follows: "A small hole is first bored by means of the proboscis from two to four inches from the tip of the shoot. In this small hole the female deposits a single oblong oval yellow egg. . . . After doing this the female with energy cuts off the shoot just below where the egg has been laid, and it falls to the ground.". Sometimes the shoot is cut only partly through, and left hanging; but sooner or later it falls to earth. The egg hatches in a few days, and the larva feeds upon the pith of the shoot. It is full-fed in about a month and enters the soil, where it pupates. Apparently the pupa remains in the soil until the following spring, but this point calls for further observation. According to Theobald, only nursery stock and bushes are attacked by this twig-cutter; and the same authority states that the only practicable treatment consists in jarring off the beetles and raking together the fallen shoots and burning them.

PEA AND BEAN BEETLES (*Bruchidæ*). The well-known pea and bean beetles were until recently placed by scientists in the series Rhynchophora, and are still spoken of as weevils by gardeners, seedsmen, and others. But careful examination has shown that these insects have no direct connection with the weevils proper, from most of which they may be readily distinguished even by the novice. For example, the *Bruchidæ* (as the family is called), have no distinct rostrum, while the antennæ are straight—not elbowed. In these and other characters they exhibit close affinities with that extensive family of leaf-eating beetles known as the *Chrysomelidæ*, of which our little "turnip flea" (*Phyllotreta nemorum*) and the Colorado potato beetle (*Doryphora decemlineata*) are notable examples; and these again are allied to the "long-horns," or *Cerambycidæ*, whose larvæ burrow in wood and feed on the fragments which they rasp away with their powerful jaws. Thus, these three families——*Bruchidæ, Chrysomelidæ* and *Cerambycidæ*—are now usually grouped together as a series called Phytophaga. But in view of the fact that the *Bruchidæ* still remain "weevils" in the popular sense of the term, an account of their doings must not be omitted from this article.

SEED EATERS.

Bruchid larvæ live in seeds and in many instances completely clear out the contents, leaving only the outer skin, in which the

grub changes to the pupa. (Fig. 15.) There appear to be about a dozen British species, but how many of these are truly indigenous it is difficult to say, since the family evinces a partiality for leguminous plants, and some of the species have undoubtedly been carried by man—along with peas and beans of various sorts—to countries far removed from their real home. This is the case with our two best-known and largest forms—*Bruchus pisi* and *B. rufimanus*—of which it can only be said that they may have come to us from the East, probably in prehistoric times. It is often stated that while the so-called pea beetle confines its attacks exclusively to the particular vegetable whose name it bears, *B. rufimanus* is equally constant in its attentions to the bean. But this seems open to question; nor is it certain that we are justified in separating as distinct species two forms agreeing so closely in appearance and habits. The insects may be more or less easily distinguished in the adult state by noting the colour of the femora, or thighs, of the fore-legs, which is red in *B. rufimanus*, and black, or almost so, in *B. pisi*. Furthermore, the black spots on the exposed portion of the abdomen beyond the wing-cases (pygidium), which are characteristic of *pisi*, are either much smaller in *rufimanus*, or may be absent.

A STRANGE LIFE-HISTORY.

The life-history of these beetles is extremely interesting. The adults hibernate under bark and in similar situations, where they are free from excessive damp. As soon as the young pods are formed in the early summer the females are ready to deposit their cylindrical yellow eggs. These are simply fixed to the outside of the pod, without protection of any kind; and, in the case of the pea, very many more eggs are laid than the contents of the pod warrants. The complete life-history was first recorded by Riley,* in America; but it has more recently been worked out in greater detail by Fabre, in France. The minute, newly hatched larva has three pairs of thoracic legs and a peculiar process on the pronotum, or first thoracic segment. By means of the latter appliance, it is able to force its way into the substance of the pod, where it burrows for a time, but sooner or later reaches the interior and penetrates a young pea. When once safely established therein, it loses its legs and becomes a fat and helpless grub. The damage done by its entry into the pea is slight and is soon almost obliterated exter-

* "Insect Life," (Riley and Howard). Vol. IV., p. 297. Government Printing Office, Washington.

nally by growth, so that in the end we have the strange phenomenon of apparently a healthy and well-developed pea which, in fact, has a grub gnawing at its centre. A single pea provides more than enough nourishment for the developing grub, which consumes a portion of the cotyledons, but always leaves the germ untouched. Moreover, it is a remarkable fact that these grubs are able to live on very short rations—or, perhaps, we should say that the food at their disposal, being exceptionally nutritious, goes a very long way. However this may be, the grub consumes a portion of the pea only a little larger than itself. Consequently, attacked peas are usually capable of germinating, although they generally fail to make good plants.

Fabre has shown that a pea may be, and frequently is, penetrated by several young larvæ, but that only one of these—viz., that which arrives first at the soft, innermost part of the seed—attains to full growth. All the others cease to feed, and then die, as soon as one reaches this area of greatest succulence—though in what manner this marvel of self-sacrifice comes about Fabre fails to explain. In the case of the broad bean, where a considerable area lying between the folded cotyledons affords a suitable feeding ground, five or six larvæ frequently establish themselves in one seed.

Before changing to the pupa, the larva invariably bores its way to the surface of the seed, leaving only the outer skin unbroken. Around this circular patch it gnaws a line of least resistance; so that when the perfect beetle is ready to emerge, it has only to push up a sort of trap-door to gain the open air. This habit renders it possible to detect infested peas and beans before the inmates have escaped, since the tell-tale circular patches can easily be recognised. (Fig. 18.) Of course, it is necessary to distinguish between these indications of the beetles' presence and the normal dimples which characterise certain kinds of peas; but this is easy after a little practice.

COPING WITH THE PEST.

This individual examination of seed is actually undertaken by certain merchants of high standing; but the average farmer and gardener could hardly spare the time necessary for such a laborious investigation. Theoretically, seeds which contain grubs, pupæ or beetles float when thrown into water, while sound seeds sink at once; but this test cannot be regarded as infallible, although no doubt it serves as a rough and ready guide. If the seed is thought to contain beetles at the time of sowing, they may be killed by plunging the peas or beans into boiling water for five seconds; after

which the seed must be passed through cold water and then sown. Whenever possible, however, the sowing of injured seed should be avoided, for the reason already given.

The best and quickest way of dealing with these pests is to fumigate all suspected seed. The seed is placed, together with bisulphide of carbon, in an air-tight box, which is then closed for forty-eight hours. As the fumes of the chemical are heavier than air, they sink downwards; and the bisulphide should therefore be placed in a saucer or shallow dish *on the top* of the seeds. One ounce of the chemical will serve to fumigate 100lbs. of seed.

NOT A STORE-HOUSE PEST.

It is perhaps worth while emphasizing the fact that pea and bean beetles are not pests of the store-house, although they are often found there in considerable numbers. They attack only the growing plant, and by the time the perfect insects are ready to leave the seeds they have already wrought all the direct injury of which they are capable. But they are the potential parents of next season's generation, and on this account all possible means for their destruction should be adopted. This is why fumigation of infested seed is so desirable a practise, although, of course, the seeds have still to be sorted if only sound ones are to be sown. As the beetles begin to emerge in the early autumn, and continue to do so throughout the winter—some actually remaining in the seeds until the following spring (Fig. 19)—the rule should be to fumigate as soon as possible after harvesting. Here the obligation of the seed-merchant ends; while the only precaution that the farmer or gardener can adopt in the open is the general one of destroying all refuse, etc. which might afford shelter for hibernating insects. Fortunately, the adult beetles rarely attack the leafage to any extent, although a few cases of injury to young pea plants are recorded. If the early fumigation of all infested seed were regularly attended to, the numbers of these insects would be quickly lessened and the loss caused by them proportionately reduced. Since, however, they are well able to subsist upon the seeds of certain wild leguminous plants, their total extermination can hardly be looked for.

KNOWLEDGE *versus* BEANS.

As an answer to the possible criticism that too much space in this article has been devoted to mere details of life-history, curious or interesting in themselves, but comparatively unimportant in their bearing upon the economic side of the questions involved, the

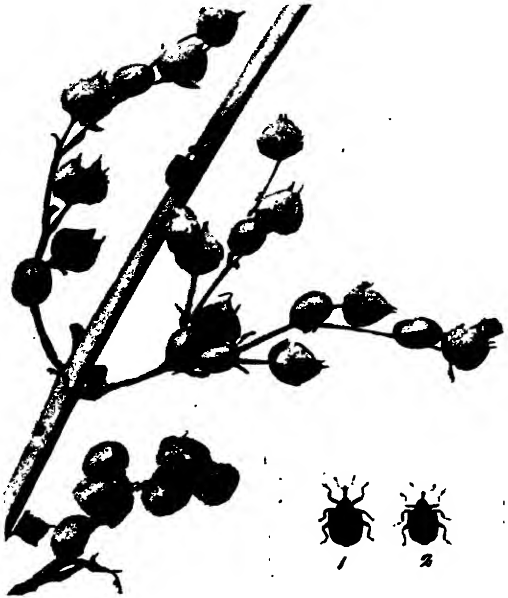


Fig. 12.

Cocoons and perfect insects of *Cionus* among seed capsules of fig wort.
Inset: 1.—*Cionus scrophulariæ*.
2. —*C. hortulanus*.

Fig. 13.

Stem of young Scotch pine (to right) killed by *Pissodes* larvæ. The bark is removed in one place to show cocoons, or "pupal beds" beneath. (To left) Roots burrowed by larvæ of *Hylobias*. Inset: 1.—*Hylobias abietis*. 2.—*Pissodes notatus*. (Magnified).

Fig 14. Nuts damaged by *Balaninus nucum.*

Fig. 15.—Broad beans and peas from which the grubs of *Bruchus sp.* have escaped.

Fig. 16.
Damage to alder stems by the larvae of *Cryptorhynchus lapathi*.

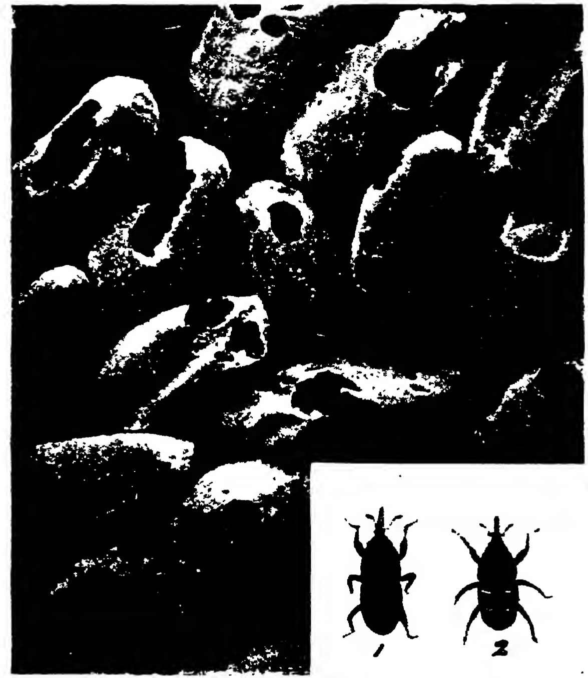


Fig. 17.
Wheat (magnified) damaged by Grain Weevils.
Inset: 1. *Calandra granaria*.
2.—*C. oryzae*. (Both magnified).

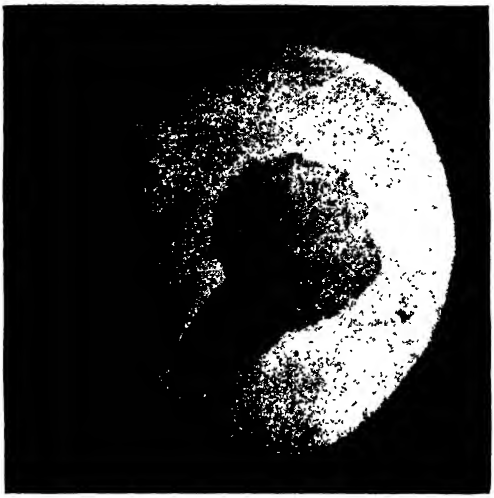


Fig. 18. Pea showing circular diaphragm which indicates the presence of *Bruchus* within.

Fig. 19.—*Bruchus pisi.* The perfect beetle lying up in a pea. (Both magnified).

reader's attention may be called to a passage in the writings of the illustrious Frenchman, J. H. Fabre, by whose recent death (1915) the world has lost one of its greatest first-hand students of insect life. He had been describing his investigations into the habits of the pea beetle, and concludes with the following words :—" To the terrible utilitarian, a bushel of peas preserved from the weevil is of more importance than a volume of observations which bring no immediate profit. Yet who has told you, O foolish man, that what is useless to-day will not be useful to-morrow ? If we learn the customs of insects or other animals we shall understand better how to protect our goods. Do not despise disinterested knowledge or you may rue the day. It is by the accumulation of ideas, whether immediately applicable or otherwise, that humanity has done, and will continue to do, better to-day than yesterday, and better to-morrow than to-day. If we live on peas and beans, which we dispute with the weevil, we also live by knowledge, that mighty kneading-trough in which the bread of progress is mixed and leavened. Knowledge is well worth a few beans."

In order to facilitate reference, a systematic list of the beetles dealt with in this article is appended, the name of the species being followed in each case by the number of the page upon which it is mentioned.

	PAGE
Order : Rhynchophora	
Family : Curculionidæ	
Calandra granaria	.. 70
oryzæ	.. 70
Cionus scrophulariæ	.. 68
hortulanus	.. 68
Ceutorhynchus sulcicollis	.. 65
assimile	.. 76
Cryptorhynchus lapathi	.. 73
Baris (Baridius) chloris	.. 65
Orchestes fagi	.. 73
quercus	.. 72
Balaninus nucum	.. 69
Anthonomus pomorum	.. 60
rubi	.. 64
Pissodes notatus	.. 75
Otiorhynchus fuscipes	.. 76
tenebricosus	.. 75
picipes	.. 67
sulcatus	.. 62
Phyllobius argentatus	.. 71
pyri	.. 71
oblongus	.. 71
maculicornis	.. 71
Hylobius abietis	.. 74
Liophlæus nubilis	.. 71
Exomias araneiformis	.. 76
Sitones lineatus	.. 73
crinitus	.. 73
hispidulus	.. 74
humeralis	.. 74
Apion apricans	.. 68
assimile	.. 68
flavipes	.. 68
Rhynchites cæruleus	.. 76
Order : Phytophaga	
Family : Bruchidæ	
Bruchus pisi	.. 78
rufimanus	.. 78

VI.—NOTES ON THE OUTBREAK OF FOOT AND MOUTH DISEASE AT BUTLEIGH, SOMERSET.

By R. Neville Grenville, of Butleigh Court.

In November, 1915, I and some of my neighbours suffered from a virulent outbreak of Foot and Mouth Disease, and I think it would be interesting if such facts as came under my immediate notice were preserved as a record in the Society's *Journal*, whilst such record might be helpful to farmers in case of any similar outbreaks in the future.

The experience of the outbreak in question shows how careful farmers must be directly there is a suspicious outbreak of any kind; and particularly how necessary it is that every one should be warned on no account to go near the possibly infected place. The tendency always is to go and have a look at the animal, either to give an opinion, or to sympathise with the afflicted owner over a cup of cider.

There were several outbreaks in this parish, but it has not been possible to trace the origin of them all; however, the particulars given of the cases tabulated below, will, I think, sufficiently show the importance of the preceding remarks, as to contact.

A few explanations may be necessary to make this clear. How the disease came first to Mr. Knight's farm has never been discovered, but once started it is plain to be seen how easily it could be spread.

The first beast was found to be ill on November 1st, and both the owner and Mr. Fairley, the veterinary practitioner, were certain that it had Foot and Mouth Disease. The Board of Agriculture Inspectors, however, held a strong opinion to the contrary, and, duly declared the farm free of disease. Mr. Knight offered to give the cow to the Board of Agriculture for a post-mortem examination, but the offer was declined and he was told that he might do what he liked with the animal. The cow was accordingly killed and the carcase sold to a butcher, named Look, who took it to Glastonbury; part of it was sent to London and was passed as sound, but the part sold in Glastonbury was condemned.

In the second case, Mr. Millard, a farmer, moved his cows from Blagrove, and about the same time Mr. Farrant, another farmer, moved some of his to an adjacent field known as Porter's Hill, situated about a quarter of a mile from the field to which Mr. Millard's animals had gone. A cart was kept in Porter's Hill field for serving the cows daily with hay from a rick in the same field, which work was carried out by the butcher who killed Knight's cow and took it to Glastonbury in the same cart as was used for the hay.

This would probably account for Farrant's cows becoming ill,

as the infection could have been carried either by the man himself or by the cart. Farrant's beasts at his homestead a mile or so away were not affected, nor were three lots of mine, in spite of some of them being in a field separated only by the width of a road from Porter's Hill, and others only separated by a road from my own infected beasts.

Our anxiety about the unaffected beasts may be imagined. They were carefully watched, given plenty of Rock Salt, and two men who attended on them were never allowed to go near any infected animals.

Fortunately the Board of Agriculture have power to stop all footpaths, to have all dogs chained up, and to prohibit all moving of animals. This was well carried out by the Board when at last, though too late, they realised that the disease really was Foot and Mouth.

I think birds may be one great source of infection, but this of course is very difficult to prevent. We noticed that after the animals were slaughtered rooks gathered and haunted the neighbourhood of the carcases, and so may well have been carriers of the disease.

The following are chronological statements of facts relating to the outbreaks :—

FIRST CASE.

1915.		
Monday,	Nov.	1—Mr. H. Fairley, Veterinary Practitioner, first saw Knight's cow and said she had Foot and Mouth Disease. At 5.30 p.m. he telegraphed to Bath, and Mr. Brand, Inspector of Board of Agriculture, came the next day.
Tuesday,	,,	2—Messrs. Brand and Berry from the Board of Agriculture saw the cow.
Saturday,	,,	6—Mr. Brand saw her.
Monday,	,,	8—The cow was killed and entrails buried.
Tuesday,	,,	9—Entrails were rooted out and eaten by two sows and eighteen suckers, and one boar.
Wednesday,	,,	10—Knight's farm was declared free.
Thursday,	,,	11—The pigs were ill and no one said anything.
Saturday,	,,	13—Knight's cart came to Mr. Grenville's timber yard, stood there for about an hour and loaded up posts and rails. Mr. Grenville's cows crossed the place where the cart had stood in the yard, going in and out morning and night from the field to the stall.
Monday,	,,	15—Knight's boar was unable to stand. The claws had come off nearly all the suckers. The sows' mouths and noses were blistered.

Monday,	Nov. 15—	A bull and heifer tied in the stall where the pigs were lying, had the disease. These pigs had never been fed on whey as it had been given to twenty-four fat pigs, which, when slaughtered a few days later, were found to be sound.
Saturday,	„ 20—	One of Mr. Grenville's beasts was found to be lame.
Monday,	„ 22—	Six out of thirteen of Mr. Grenville's cows were found to be ill of Foot and Mouth Disease. The field in which these cows were is bounded on one side by the road, along which is a wire fence. On the other side of the road is another field also with a wire fence, and in this field the cows were not affected with the disease, although constantly up against the fence which separated them from the diseased cows by only thirty feet. At no time did any of Mr. Grenville's men go to Mr. Knight's farm nor any of Mr. Knight's men to Mr. Grenville's Homestead, with the exception of those with the cart above mentioned, for many weeks prior to the outbreak at Knight's.

SECOND CASE.

Tuesday,	Nov. 2—	Mr. J. Millard moved one lot of fifteen dairy cows east from Blagrove to Park Gates.
Monday,	„ 8—	These cattle were moved back west to Blagrove Moor.
Monday,	„ 15—	These cattle were again moved east to a field called "Clyse Common," each time going along a drove through the middle of Knight's farm and adjoining the fields where the cattle were infected.
Wednesday,	„ 24—	One of these cows named "Spider" was noticed to be lame.
Saturday,	„ 27—	Foot and Mouth Disease discovered on Homestead.

The following facts relate to both outbreaks :—

The same men who fed the cattle at the Homestead also fed the infected cattle.

The cart that served these cattle came from the Homestead, as did also the cake bags.

No one came or went to Knight's farm during this period.

Forty-four cattle were destroyed altogether, and thirteen pigs.

The inference seems to be that the cart was the carrier of the infection—probably by the mud on its wheels—to the cows at the Homestead.

VII.—WEST COUNTRY GRASSLANDS.

By Winifred E. Brenchley, D.Sc., F.L.S. (Rothamsted Experimental Station).

One of the great problems every farmer has to consider is that presented by the multitude of plants, other than those of the crop, which appear everywhere on land under cultivation. These plants, known in common parlance as "weeds," engender such competition with the legitimate occupants of the soil that the latter are unable to reach their maximum development unless strong measures are taken to reduce the intruders to the narrowest possible limits. On grassland it is not easy to define a weed. Most of the grasses, clovers, and miscellaneous plants are of greater or less feeding value, this value depending partly upon conditions of growth, climate, and the nature of the soil, as well as on the inherent qualities of the plants. Some, however, such as thistles, nettles, woodwax, and autumn crocus, are definitely troublesome in one way or another, and may always be classed as weeds. Others, such as Yorkshire fog, barley grass, and hardheads, are either of very low feeding value or else cause trouble under certain circumstances, so that occasionally they also enter the category of weeds.

With a view to gaining definite information with regard to the weeds of grassland, tours were made in representative areas of Gloucestershire and Somerset during the summer months of last year (1916). Gloucestershire was visited during the first three weeks of June, immediately prior to the hay-cutting, Somerset in late July and August, the tour beginning some time before the last of the hay was harvested.

By the great courtesy of all the farmers visited, it was possible to examine the fields closely even when they were intended for hay, a privilege much appreciated which contributed in great part to the success of the investigation, for more can be learned from the natural growth of the herbage prior to cutting than from mown or grazed land. Altogether 340 fields were examined in detail, full notes being made in each case. In addition to this, much land was inspected in a more superficial way in connection with special points of interest. My thanks are especially due to Mr. C. T. Gimingham (Bristol University), Mr. Harle (Tortworth Estate Office) and Mr. Burton (Agricultural Organiser for Somerset), for obtaining the many needful introductions; and also to those farmers and landowners who so courteously furthered the work by according me permission to visit their land and by giving me much valuable information.

The districts visited comprised parts of Mid-west Gloucestershire from Berkeley in the north to Almondsbury in the south-west; North Somerset, from Yatton to Bridgwater, including parts of Sedgemoor and other peat areas; and West Somerset, from Porlock to Williton.

The average rainfall from 1875–1909 at Stroud (Glos.), was 29·81 inches, but at Clifton in the same county it was 34·88 inches. In Somerset the average at Street for the same period was 29·94 inches. As the figure for the whole of England for 1875–1909 was 32·84 inches, the areas under investigation received rather less than the average amount of rainfall, except at Almondsbury and Henbury, two places near Clifton.

The areas embraced a large range of geological formations, but for practical consideration they may be grouped in five sections, according to the general nature of the soil.

(*a*) *Alluvium.*

Much of the land bordering the Severn and the Bristol Channel, in some places for miles inland, is heavy retentive clay that at some period was laid down by deposition from water. The alluvium was examined at Berkeley and Hill in Gloucestershire, and at Bleadon, Lympsham, Woodspring, Brean Down, Brent Knoll, Highbridge, Minehead, Porlock, Dunster and Carhampton in Somerset.

From their origin the alluvial soils are low-lying, so that the water supply is usually good and drought does not affect the vegetation to any great extent. During periods of severe drought when the fields on the higher ground are parched and brown the alluvial fields afford a striking contrast with their healthy green herbage. On the other hand in very wet seasons such fields are apt to become waterlogged.

Owing to the plentiful supply of water the vegetation on the alluvium is very lush, and is composed of a large variety of plants. Among the grasses, the fine wiry types, like Sheep's Fescue, are not very conspicuous, but the broader leaved grasses, as foxtail, cocksfoot and rough and smooth-leaved meadow grass, grow abundantly and well. In some districts, as at Lympsham, barley grass grows very abundantly, but is less welcome than some of the other species. Among the miscellaneous plants tall buttercups and rushes are pre-eminent, but the following are also very conspicuous—daisy, ragged robin, sorrel, cowslip, selfheal and dandelion. Many other species occur but none are essentially characteristic of alluvium alone.

Many of the fields are gently undulating with broad ridges and

shallow furrows, a relic of the system of arable farming which obtained many years ago before the land was allowed to fall down to grass. The difference of level and the consequent difference in plant population makes the herbage irregular and uneven, and adds to the difficulty of mowing such fields, as damage is often done to the mowing machine by the unevenness of the land. When the fields lie somewhat high or are on very pervious subsoil the difference in the vegetation of ridge and furrow is not very marked. In most cases, however, the fields are low-lying or are over heavy subsoil, so that water congregates at the level of the furrow and influences the plant population very considerably.

The gullies are sharply outlined by dark lines of rushes, chiefly *Juncus glaucus* and *J. communis*, often associated with strong growing foxtail and sometimes with barley grass. Occasionally rushes are rare or absent and the foxtail dominates the situation. The rushes act as an excellent indication of change of level. Near the banks of the Severn, as at Hill, the drainage is very poor and the rushes are abundant in the gullies and are also spread all over the fields. As one goes inland the land rises slightly and the rushes withdraw to the gullies only; as the ground rises still more, with consequent improvement of drainage, they die out gradually.

The tall buttercup is another plant that is fond of damp situations but it cannot stand as much water at the roots as the rushes. At the lowest levels no buttercups occur in the furrows, but they are abundant all over the ridges. Where the ground is slightly higher they are still practically absent from the furrows, but they also disappear from the crests of the ridges which are apparently too well drained to suit them. Where the drainage is still better and the rushes are less thick in the furrows the tall buttercup descends to join the rush and disappears partly or wholly from the ridges, its place being taken by the allied bulbous buttercup. This was particularly well seen at Berkeley and Hill.

At flowering time the tall buttercup is a great feature of the Severn Valley, as it clothes the headlands of the ditches by the roadsides for miles and also occurs in carpets over the fields. It is not much desired in the pastures and yet the best land is often full of it. Its presence may possibly indicate that the land is in good heart, as well as the presence of abundance of water. When the grass is in full flush cattle will not eat flowering buttercups but push them aside impatiently, trampling them down and neglecting them until the more favoured herbage has been consumed. Sheep will clear them up, but even they are not very keen. The grazing is usually very thorough when buttercups and thistles abound, so

it may well be that these weeds indicate good soil and good feed, although they are themselves disliked by cattle. It is only at flowering time that the distinction between tall and bulbous buttercups is clearly evident, as both species after mowing take a subordinate place.

The draining gullies and depressions are often colonised by various kinds of docks. The Broadleaved dock likes to congregate in places where the water spreads out to flood the fields. The sharp dock and the blood-red dock haunt the gullies and also shady places and edges of fields. Sheep will eat them, and it is said that both docks and hogweed can be eradicated by pasturing sheep in the fields in which they appear. Huffcaps (*Aira caespitosa*) are fond of damp places and indicate poor drainage.

(*b*) *Clay soils other than alluvium.*

These were seen on the Lower Lias at Cam, Hillesley. Almondsbury and Berkeley Heath (Glos.), and Brent Knoll (Somerset), on the Red Marl at Wickwar and Berkeley Heath (Glos.) and on the Coal measures at Wickwar. As the land is usually higher than the alluvium the characteristic association of rushes and tall buttercups is much less in evidence, but close examination shows that the flora is otherwise very comparable in the two cases. On the higher ground the damp-loving species are naturally absent.

An unusual type of grassland occurs on the Lower Lias at Almondsbury. The rising pastures are studded with clumps of low hawthorns, brambles and wild roses, which often do not rise more than a few inches above the ground and which are never very high. The outstanding grass is False Brome, and its pale yellow-green foliage gives the pastures a most curious appearance. There is an abundance of other plants, one such field possessing 34 different species, exclusive of grasses. This type of pasture is very distinctive and is totally unlike any of the grassland commonly seen.

(*c*) *Peat.*

In Somerset, as at Westhay, Shapwick, Chedzoy and Yatton, there are great tracts of peat moor and in these areas the vegetation is often quite distinctive. A large number of miscellaneous plants join the grasses and the vegetation is far more varied than in other places. Tall buttercups are frequent, but do not dominate nearly so strongly as on the alluvium. Owing to the nature of the substratum, the water supply is even more plentiful than in the latter case and many typical damp-loving plants are abundant. Ragged robin, meadowsweet, marsh bedstraw, cotton grass, creeping jenny, and various species of mint and sedge are frequent. In exceptionally

well watered gullies real marsh or water plants appear, such as forget-me-not, marsh marigold, ladies' smock, watercress, arrowhead, penny-wort and purple loosestrife. Rushes are frequent and *Juncus articulatus* is often found in addition to the *J. communis* and *J. glaucus* which are usual on the alluvium. A very striking plant on the peat areas is the fringed hardhead which occurs in great plenty in some districts, such as Westhay and Yatton. Among the more usual pasture plants, mouse-ear chickweed, moon daisy, cat's ear, silverweed, tormentil, selfheal, sorrel and dandelion are conspicuous.

In some places, as at Yatton and Brent Knoll, the opinion is held that some of the finest pasture is that on clay land over a peat subsoil, and such fields are sometimes worth £50 or even £100 per acre. The surface clay is retentive of moisture, but the peat subsoil tends to prevent waterlogging and to keep the surface in good condition.

Chedzoy, on the edge of Sedgemoor, is much below sea level, and the water is kept back by strong dams some miles away. The soil is a curious mixture of peat and sand, tracts of the two types occurring side by side. On some of this land it had proved impossible to obtain a stand with the usual bought seeds, so a reversion to the old method of farming was adopted with success. "Wild hay seeds" were obtained by shaking hay thoroughly before putting it through the chaff cutter, and after sowing these seeds a good stand was obtained. A noticeable feature of these fields was that after mowing very few weeds were evident on the peat soil, tall buttercup, sorrel, thistle and hardhead summing them up. As one passed to the adjoining sand—the so-called "magnesia soil"—the weeds increased in number and abundance, and plantain, hawkbit, daisy and dandelion were conspicuous. An excellent bottom was obtained by the use of the wild hay seeds, and an equally good result was obtained when the method was applied to the clay soil on another part of the farm.

(*d*) *Calcareous Soils.*

Various types of calcareous soils were seen, including the Mountain Limestone at Cromhall, Wickwar, Tortworth (Glos.), Bleadon and Woodspring (Somerset), Wenlock Limestone at Falfield (Glos.), Marlstone at Cam and Hillesley (Glos.), and at Brent Knoll (Som.), Inferior Oolite at Cam, Ludlow Beds at Berkeley (Glos.).

Many of these soils are on high grounds and the vegetation is quite different from that on the low levels. On the hillsides and the exposed limestone pastures the grasses tend to grow small and fine

and are characterised by much sheep's fescue, which is wiry and able to withstand much drought. On the mowing fields luxuriant growth is obtained in which daisy, moon daisy, pignut, yellow rattle and sorrel are abundant. Rough brome and quaking grass are frequent and various species of orchids occur to some extent. At the lower ends of the fields tall buttercups are very abundant but they die out on the hillside, giving place to bulbous buttercups. Other plants that are often seen on limestone soils are yarrow, convolvulus, mouse-ear hawkweed, field scabious and betony.

(*e*) *Light and Sandy Soils.*

These were found on the Millstone Grit at Cromhall and Wickwar, Old Red Sandstone at Berkeley, New Red Sandstone at Williton and Carhampton, and Midford Sand at Cam.

The vegetation of the Millstone Grit much resembles that on the limestone soils, the difference chiefly consisting in variations in relative abundance rather than in species. Comparatively little Red Sandstone was seen, so that it was not possible to ascertain if any specific differences occur on it.

Effect of Herbage on Stock.

Practical experience in dealing with grassland shows that the fields vary considerably in their capacity for milk production and in the quality of the milk, butter and cheese that is obtained from the cattle grazing thereon. The cause of this variation is still much of a mystery. Generally speaking, the better the land the better the milk. Yet it is possible to have two adjacent fields, both clothed with exactly the same type of herbage, one of which gives great quantities of milk or butter of a super-excellent quality, while the other generates low milk yields, poor butter, or inferior cheese. In some cases the difference in the quality of the herbage is so marked that "show butter" or "show cheese" is always made from the milk from one particular field. It may even be necessary to consider whether quantity or quality is needed for any particular purpose before selecting the grazing fields for the cattle. The same thing is seen with regard to fattening beasts—one field may fatten cattle very quickly, while the next will carry them for weeks and months and never bring them beyond the stage of store beasts. At Chedzoy the hay from certain fields on the peat is of such low feeding value that it is termed "starving hay," as it is maintained that animals will starve if fed upon it without adequate balancing with other foodstuffs. On the other hand some fields are so constituted that they will bear being mown every year, providing good

crops of hay of excellent feeding value, and yet these fields, on the alluvium at Dunster, are seldom or never dressed in any way. Farmers say the "proofiness" of the land varies, but while this provides a useful term to indicate what is meant, it does not give the slightest explanation of the cause. Careful observations of the herbage were made in every field visited which had any special reputation, whether good or bad, but no light was thrown upon the problem. The fields which made bad cheese at Chedzoy and Woodspring Priory did not present any noxious weeds nor was there any difference in the distribution of the plants to account for the inferiority of the finished product. At Woodspring ribwort plantain, yellow rattle, cowslip, hawkbit, and tall buttercup were the most evident weeds, and at Chedzoy thistles, plantains, hawkbit, agrimony and hardhead were the most noticeable, none of them being plants which have any bad reputation as affecting the quality of cheese.

A "prize butter" field at Cam showed exactly the same characteristics as an adjoining field which makes great quantities of milk and is preferred to any other by the cattle if they can get access to it. Tall buttercup, mouse-ear chickweed, ribwort plantain, pignut, hogweed and dandelion were plentiful in both fields.

WEEDS THAT ARE HARMFUL TO STOCK, MILK, OR BOTH.

Dairy products, milk, cream, butter and cheese, are notorious for the frequency with which they exhibit some imperfection of flavour, amounting in many cases to an absolute taint. Many are the surmises as to the origin of this unwelcome taste. Frequently it is due to lack of cleanliness in the course of handling and preparation, to dirty milking or dirty dairy utensils, and some farmers and dairymen stoutly maintain that taint in milk is always caused in this way. Sometimes, however, even with the most scrupulous attention to cleanliness from beginning to end, the milk or its products fail to reach the requisite standard of flavour. This suggests that the harm may be done by some part of the animal's food, and if it occurs while the cows are out at grass the source must be looked for among the various plants of the herbage.

Enquiries were made of a number of West-country farmers and the result was surprising in that very few herbage plants were accused of tainting the milk. Here and there one plant or another was held up to opprobrium, but only one—garlic—was universally condemned. Outsiders often imagine that buttercups tend to affect the flavour, but in no single instance was this idea upheld even by farmers who work great tracts of alluvial land that are golden

with masses of buttercups in June. Ergot, a fungus which sometimes affects grass or corn, taints the milk badly if it be given to the animals, and care should be taken that their food is free from it. In addition. it acts as a powerful drug and may cause poisoning—a further reason why care should be taken to ensure its absence.

Some of the plants accused of harming the milk also have a bad effect on the cattle, while a few others are directly injurious to the animals but do not seem to taint the milk. It is difficult to draw a hard and fast line between the two classes of harmful plants, but some attempt may be made to rank them in two divisions.

(*a*) *Plants affecting milk and sometimes animals also.*

GARLIC (*Allium vineale*). (Fig. 1 B). It is difficult to distinguish this plant among grass until it sends up its globular heads of bulbils and flowers, as its leaves are short and very narrow, almost cylindrical. It is everywhere accused of imparting its own flavour to dairy products, but opinions differ as to how the mischief is worked. A few people told me that it has nothing to do with the cow, but that it is brought about by small pieces of garlic leaves falling into the pail during milking. Except in a very few cases this idea may probably be dismissed. One Gloucestershire farmer holds that garlic taints the cows' breath, as it does that of man, and that in some mysterious way this influences the milk. This, again, may be rejected as improbable. It is far more likely that the direct taint is imparted to the milk in the process of secretion in some physiological manner not well understood. It may be that the taint is carried in the fat globules more readily than in the rest of the milk. One dairy farmer at Cromhall has fed cows on "garlic wheat" or even on "garlic with wheat in it" and has had no suspicion of trouble nor complaints of the milk being tainted. If, however, butter had been made he thought that there would have been trouble owing to the liberation of the taint from the fat globules. Be this as it may, the general opinion is that it is wise to keep milking cows out of fields known to be infested with garlic, at least during the growing period of the plant in spring and early summer. In some cases such fields are mown each year, so that the cattle are never in them when the garlic shows; it is then quite safe to feed off the aftermath. When the land is grazed store cattle and bullocks are run in the infested fields. With such beasts it is considered that a little garlic acts as a tonic or appetiser, and that they are rather the better than the worse for its presence.

A closely allied plant, RAMSONS (*Allium ursinum*) (Fig. 1 A.)

Fig. 1.—Weeds accused of tainting milk.

A—Ramsons *(Allium ursinum)*.

B—Garlic *(Allium vineale)*.

sometimes causes trouble in the same way as ordinary garlic. The plant is readily distinguished by its thin, flat, spreading leaves. It is seldom that it intrudes into the fields, as it prefers shady places and hedgebanks. In some districts, as at Dursley, it is exceedingly abundant, and it occasionally happens that milking cows gain access to it with dire results. The flavour is strongly accentuated if the milk be scalded.

HEMLOCK (*Conium maculatum*). This large, rather handsome plant frequents the ditches in some places. It is generally regarded as being exceedingly poisonous, causing illness or even death in cattle if eaten by them. In one case, at Cromhall, it was said that animals will eat a good deal of hemlock without injury, but that it is apt to make the milk taste. The plant was not actually seen on this occasion, but it is possible that the name hemlock has been applied to some very similar plant of the same family lacking in the more poisonous attributes of its ally. Many of the large white Umbellifers are so very much alike that it is often easy to mistake one for another unless a very close investigation is made. In any case it is safer to regard the plant as pernicious and to remove it out of harm's way by cutting if cattle are run in the fields affected by it.

MOON DAISY (*Chrysanthemum leucanthemum*). There is much controversy with regard to the effect of this plant on milk. In some parts of the West Country large areas are thickly covered with moon daisies, but no direct evidence or opinion was obtained of their tainting nature, either here or in Notts and Derby in 1915. It was occasionally said that they " might " make the milk taste.

WOODWAX (*Genista tinctoria*). (Fig. 2 A). The plant somewhat resembles a dwarf broom bush, growing in clumps about 1–2 feet high, and in some localities is scattered over the pasture in abundance. Elsewhere it is quite absent and unknown to the farmers. In the Gloucestershire districts visited it was plentiful at Cromhall (Mountain limestone), Wickwar (Coal measures), Berkeley (Ludlow beds), and Almondsbury and Henbury (Lower Lias clay), while it was not seen at all in the Somerset areas investigated. Wherever it does occur it is heartily disliked, as it depreciates the value of the land both for grazing and for hay, and also it is supposed to make the milk bitter if eaten by milking cows. As a general rule cattle will not touch it; they will not eat it in hay and they neglect the clumps of pasture in which it grows, causing a great waste of herbage. Sheep will eat it if they are hungry, but they are not at all fond of it.

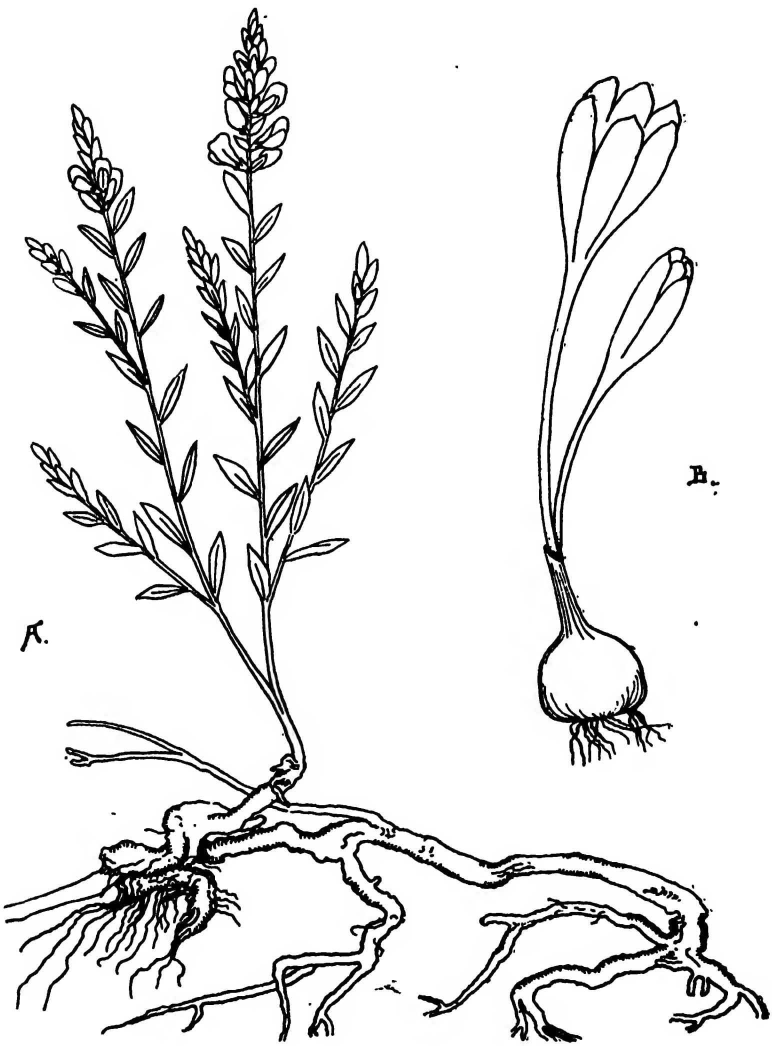


Fig. 2.—A—Woodwax *(Genista tinctoria)*, disliked by amimals and said to make milk bitter.

B—Meadow Saffron *(Colchicum autumnale)*, poisonous to stock.

The plant is so very local in its distribution that it is probably associated with special conditions of soil and moisture. There are indications that it usually occurs where the soil lacks lime, and that a good dressing of lime will help to eradicate the pest. Although it is frequent in some fields on the Mountain Limestone, it must be remembered that though the subsoil be pure limestone the surface soil is often deficient in lime.

It is often thought that woodwax grows in the very driest parts of the hillsides and pastures, but an examination of its incidence of association with other plants throws doubt on this idea. In some fields, as at Cromhall and Wickwar, it grows abundantly on the lower flats which are obviously very damp or wet in places. Even when the abundance of woodwax clothes the tops of the hills, as at Henbury, it is most frequently accompanied by numbers of marsh thistles (*Cirsium palustre*), which presumably indicate an adequate supply of water caused by insufficient drainage. Even the top of a hill may be badly drained if an impervious pan prevents the surplus water making its way down freely.

The plant has an almost uncanny habit of spreading to a great distance by means of its underground parts, and of making rapid headway when once it gets a start. One field at Henbury, in which it was not noticed in 1915, was grazed "as close as a billiard table" at the end of April last year, and by the middle of June clumps of woodwax were flourishing in the middle of the field, many dozen yards from the nearest clumps in the next field, from which apparently the intruders must have had their origin. The season of 1916 seems to have been very favourable to the spread of the plant and it is essential that some means be found of checking its growth, as it bids fair largely or wholly to destroy the value of the pasture in some places.

(*b*) *Plants affecting animals but not milk.*

MEADOW SAFFRON (*Colchicum autumnale*). (Fig. 2 B). The plant is very poisonous, and is locally very abundant. The flowers appear in the autumn, without any leaves, and the seed vessel remains below the surface of the ground after the flowers die off. The leaves appear in the Spring and the seed vessel is brought up to the surface of the ground at the same time. At Cam it was advised that when Meadow Saffron is present the field should be cut for hay and not grazed either in Spring or Autumn when the plant is above ground, as all parts are poisonous. Grazing is safe in summer and winter, during the resting periods of the plant, but great care should be exercised to clear the stock out of the fields before growth begins.

PURGING FLAX (*Linum carthartícum*). (Fig. 3 C). This tender little plant, with its white flowers, is occasionally seen in ordinary pasture or mowing land and is a typical denizen of down pastures, especially in limestone situations. Hay in which this plant occurs may cause purging or even death to the animals that eat it. It is probable that the harmful effect is the result of prussic acid poisoning, as this substance is developed by the plant under some conditions. Consequently pasture containing this flax should be looked on askance.

HORSETAIL, SNAKEPIPE, OLD MAN'S BEARD, ETC. (*Equisetum spp.*). (Fig. 3 A.). At Chedzoy, on Sedgemoor, this plant has a very bad reputation for causing scour in cattle, though horses and sheep are said to be unaffected by it. Various species are classed under the popular names and possibly some cause scour while others are harmless. This may account for the indifference with which the plant is regarded in some places and the dislike of it in others. Cattle do not like it but eat round the clumps and leave it as far as possible.

The distribution of the plant is very localised, and one field may be badly infested and be known as a " very badly scouring field," while the adjoining meadow is innocent of any trace of the culprit, as was seen at Chedzoy. Possibly *Equisetum* is a sign of want of lime, though there is no direct evidence to this effect. It is killed by the first frost and then there is no further danger of scouring, as it does not spring up again until the following season.

HUFFCAPS (*Aira caespitosa*). This is a very coarse tufted grass growing by preference in badly drained fields on heavy land in great tussocky clumps, and is of wide-spread occurrence. The leaves are exceedingly rough and are disliked by animals. The plant is regarded as being detrimental to stock, and in many leases a clause is inserted providing that the land must be kept clear of it by cutting or otherwise. If a wet field containing *Aira* is neglected for some time it may get completely overrun by the pest to the more or less complete exclusion of useful grazing plants, as in Geescroft field at Rothamsted, which gives a further reason for its eradication.

WEEDS REQUIRING SPECIAL ATTENTION.

Among the numerous species of plants which throng the grasslands there are a few which stand out pre-eminently and demand attention. They are mostly of widespread occurrence, some of them appearing on any and every soil and under all possible circumstances, others being more local in distribution, but so abundant

that they must be reckoned with. Happily, with judicious treatment, most of the dominant weeds can be turned to useful account, so that the time spent in keeping them under also helps to provide a certain amount of food for the beasts.

Nettle (*Urtica dioica*). This is one of the most domesticated of plants, as it has a habit of appearing close to buildings and in places and corners touched by the hand of man. It seldom takes the open, level field, but it haunts the sheds, orchards, ponds, gates, trees and the edges of fields where traffic passes near. At Falfield a sharply defined band of nettles runs down the middle of a large grazing field. Enquiry showed that years ago the field was the old rickyard, and the site of the cart-road down the middle is now demarcated by nettles. Where water-holes have been dug it is quite usual to find the dumped material on the sides colonised by nettles. Rabbit warrens are another favourite haunt. An unusual use of these stinging plants was observed at Berkeley. A double dead set hedge separated two fields, and the enclosure between was filled with a dense mass of nettles. It was not quite obvious whether this was the original intention, but at any rate a more effective hedge could not be desired while the nettles were in their prime. In places where the land dips irregularly, especially on rough grazing pastures like Bleadon Hill, it is very usual to find nettles congregating thickly in the hollows, though they may be absent elsewhere.

Where nettles do favour a situation they usually grow very freely and luxuriantly, and dominate to the practical exclusion of other more useful plants. Growing, no animal will touch them, and they simply cumber the ground. It is usual to let them grow up well and then to cut them at a late stage in growth, simply to get rid of them. At Falfield it was stated that if nettles are cut when about six inches high sheep will eat them freely, and the further development of the plant is seriously hindered. They are far less plentiful and less often seen on land that is mown than on grazing land, thus indicating that they do not care to be disturbed by cutting too frequently.

Thistles (*Cirsium arvense, etc.*). Thistles of various kinds are the weeds that attract the most attention on grassland of all types. Like the nettles they tend to congregate in waste places and hollows, but in addition they spread freely over the open fields, particularly on pasture that is not generally mown. They congregate wherever there is a break in the ground as in depressions, on banks, heaps, etc. They are not usually plentiful on sown-down grass unless it has been down for a great number of years.

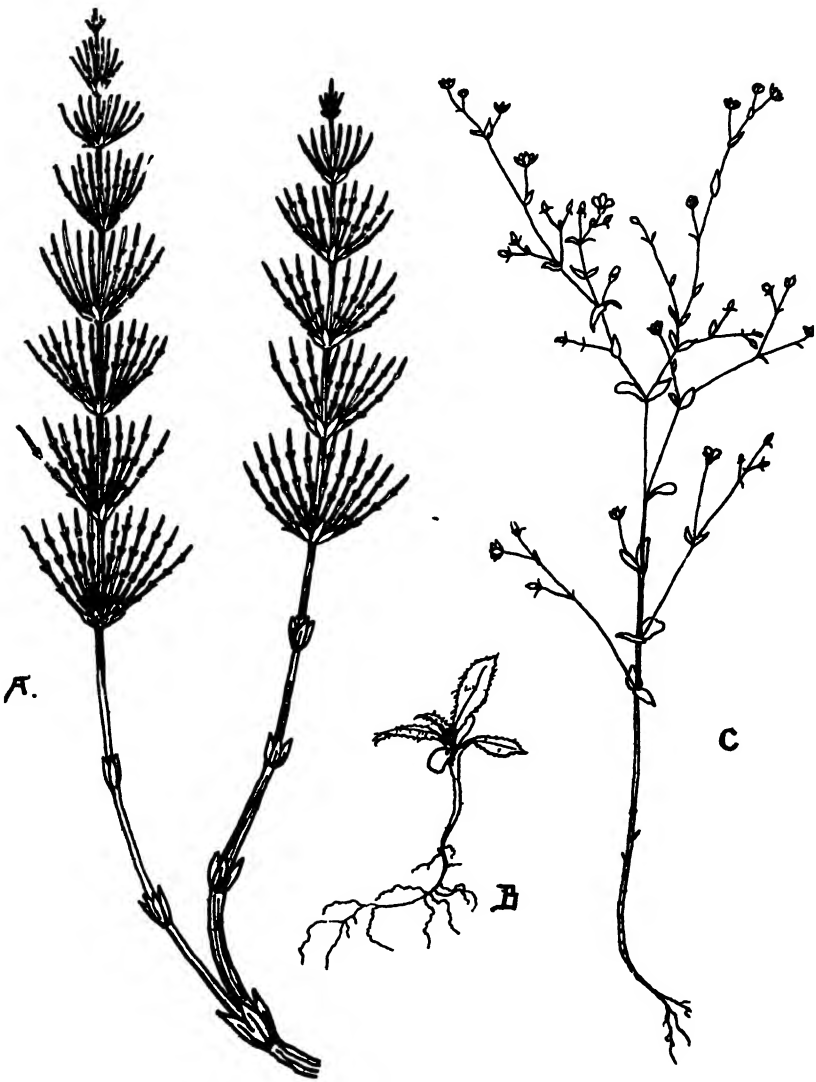


Fig. 3.— A—Snakepipe *(Equisetum arvense)*, said to cause scour in cattle.

B—Thistle Seedling *(Cirsium arvense)*.

C—Purging Flax *(Linum cartharticum)*, may cause illness or death in animals.

The heavy alluvial flats bordering the Severn at Hill showed a most luxuriant growth of thistles which in these days of shortage of labour were waist high by the beginning of June. This means considerable loss, as the cattle neglect areas infested by thistles, leaving them ungrazed.

The Sheep Thistle (*Cirsium arvense*) is the most common species and patronises grass and arable land alike, growing freely almost anywhere, though it is not plentiful on low-lying peat. It spreads rapidly by means of underground stems, every little bit of which will grow and give rise to new plants. Also the plant seeds freely, but there is much disagreement as to whether the seeds are efficacious. Some farmers hold that they are abortive and will not germinate and grow. This is certainly a fallacy, as at Rothamsted several thistle plants have been raised from seeds buried in soil from the experimental fields. The plants were indubitably seedlings (Fig. 3 B) as the cotyledons were carefully observed in each case, and the growth of the plants compared with that obtained from pieces of buried stems. The probability is that the seeds are quite virile, and that if they fall on suitable soil, as on arable land, they will give rise to new plants, which however are in danger from the processes of cultivation like all other seedlings, as the young roots are quite delicate and are cut off by the hoe. The seeds that fall on grassland may fail to germinate for lack of a suitable medium, and this may account for the persistence with which many grassland farmers maintain that thistles will *not* grow from seed. Under any circumstances it would be folly to presume on this idea and to neglect to cut thistles until after they have shed their seeds.

The best and indeed only method of keeping thistles under is by cutting, and the time and season of doing this is of importance The underground stems of thistles are storehouses of food material which is kept in reserve from one season to another. When growth starts in the spring the plant draws on this store of food so that the underground storehouses gradually become exhausted during the early part of the season. Later on the plant manufactures more food in its leaves than it needs for immediate use, and the surplus is sent down to be stored up for use in the following year. The great thing is to cut thistles when the underground stores are exhausted, before the re-storing begins. This stage is probably reached about the time the thistles are in bud, before the flowers expand. If they are cut too soon, the vigour of the plants is enhanced, as is expressed in the local saying that "you get two thistles instead of one." If cut too late the underground food stores are filled up and the object of cutting is defeated. It is usually best to cut twice in the year,

in late spring and autumn. At Carhampton and elsewhere a light mower with one horse was recommended for use, but good work was being done at Williton with a reaper with the rack removed. Cattle eat the thistles freely directly they are cut, but leave them if they are left on the ground to wither and get dry before the beasts are turned in.

BLACK BULL THISTLE (*Cirsium lanceolatum*) is of frequent occurrence, but rarely occurs in large numbers. It is seldom seen when the land is really good, but it likes to colonise such waste places as the tops of ditch-banks where the land is poor. It was seen rather plentifully at Woodspring in a field on the alluvium that was very damp, where it was intermingled with rushes. To eradicate the plants they can be cut at any time and the cut stumps treated with a handful of salt.

STEMLESS THISTLE (*Cirsium acaule*) and MILK THISTLE (*C. nutans*) occur rather freely on the limestone pastures, as on Bleadon Hill and at Woodspring Priory, but they are not of any economic significance.

MARSH THISTLE (*C. palustre*) is of widespread occurrence and generally indicates a plentiful supply of water in whatever situation it is found. It sometimes marks the outlet of springs in the limestone rocks, high up in the hills, but it is rarely in sufficient quantity to cause trouble.

YELLOW RATTLE, RATTLE BOX, RATTLE JACK, YELLOW BASKET, YELLOW JACK (*Rhinanthus Crista-galli*). This plant stands almost alone among grassland weeds in its action on other plants, and so little is generally known about its habits that its significance is not realised and too often it is allowed to spread unchecked. Yellow Rattle does not draw all its food supplies from the soil and from the air but lives chiefly at the expense of other plants, for which reason it is called a parasite. The roots are furnished with suckers which attach themselves to the roots of various grasses (and perhaps other plants also) and suck the nutritious juices out of the host plant for the benefit of the parasite. Obviously, if Yellow Rattle is very prevalent in a field the useful herbage has a poor chance of making good growth. Wherever it occurs, in great patches or over whole fields, the other plants are poorly developed. In some places, as on the water meadows at Dunster, the herbage is practically killed out in patches. Hay containing the plant is apt to blacken and to be rejected by cattle. Yellow Rattle is an annual coming up from seed in the early spring and ripening fresh

seed by the usual haytime, so that when the hay is cut and carried the pest is scattered far and wide to begin its insidious work in fresh places as opportunity offers. The annual nature of the weed affords a means of eradicating it fairly readily if care and patience be exercised. If the field is to be mown, the first crop should be partly sacrificed by cutting very early, before the Yellow Rattle has any opportunity of ripening its seeds. It may be necessary to do this two or three times, as the seeds lie dormant in the ground for some years, so that a fresh crop will appear from the old seed for some little while. At Henbury it was suggested that the fields be grazed instead of mown, as by that means the seedlings are kept under as soon as they germinate. It is most important that the nature of this plant should be recognised, as it is much too prevalent in the West Country, and in far too few cases is any attempt made to eradicate it. Occasionally it invades the arable fields, when it is capable of utterly ruining a crop covering several acres, as was seen at Shrewton (Wilts) in 1911, when the barley was badly attacked.

BINDWEED (*Convolvulus arvensis*). Although this is usually considered to be a weed of arable land, yet in some cases it is a great trouble on grass land, as at Carhampton, especially on pasture that has been seeded down at some time or other. The long trailing stems clothed with fair-sized leaves cover the surface of the ground and smother out the herbage to a great extent. No remedy or method of eradicating has been suggested.

HARDHEAD (*Centaurea nigra*). This is a common weed but is not often much trouble. It seems to grow very strongly if a field is grazed exclusively by cows. One such field at Carhampton was a mass of hardheads, but now that sheep have been run in as well the hardheads are disappearing and a better hay crop is obtained. The latter result is not definitely attributed to the sheep, but it is quite probable that the reduction in the coarse growing hardheads has given the herbage a better chance.

OTHER WEEDS AND GRASSES OF INTEREST.

(*a*) ***Weeds.***

COUCH (*Triticum repens*). In laying down fields to grass it is necessary to eradicate this weed as much as possible, as it takes possession of the land so terribly. One five acre field at Chedzoy used to be full of it. It was ploughed up and 72 dung cart loads of couch were removed from half the field. It was again ploughed and again nearly as much couch was removed. The couch was made into a rick as high as could be pitched, the intention

being to use it as saddles for corn ricks. Cattle got access to the rick, helped themselves, and did really well on it, finally demolishing the whole stack though it was never given to them.

HOGWEED (*Heracleum Sphondylium*). Generally speaking this coarse growing weed confines itself to the outskirts of fields and hedges, but sometimes it is found distributed over the whole area. It is liked by animals as it makes sweet hay, but its coarse growing nature renders it an undesirable denizen of the fields. At Brent Knoll I was told that hogweed can be eradicated in one year by putting sheep on the land.

PLANTAIN (*Plantago spp.*). Several species occur on grassland, but RIBWORT PLANTAIN (*Plantago lanceolata*) is by far the most common. In some mowing fields it grows so profusely as almost to form a carpet, and everything else has to give way to it. It is supposed to be very heating for animals, hence the local name "hot-grass" (Woodspring Priory), and owing to the abundance of sap it needs much drying when made into hay.

HOARY PLANTAIN (*Plantago media*) is much liked by farmers as it is a sign of really good land, and at Chedzoy it is held to be an unfailing indicator in this respect.

WILLOWWEED (*Polygonum Persecaria*) nearly always indicates dampness of soil. It has a tendency to congregate in the lower parts of the fields and in the gullies. It makes fine sweet hay, but takes much drying because of its sappy nature.

REEDS (*Arundo Phragmites*). On the low-lying alluvial and peat lands, where the fields are intersected with numerous ditches and watercourses, the reeds often grow very abundantly. They are protected and harvested and are used for thatching instead of straw.

SILVERWEED (*Potentilla anserina*). This grows very abundantly on moors and is quite good for hay, but it needs careful drying, as otherwise it makes hay heat badly.

(*b*) *Grasses.*

Pasture grasses are very varied but a few stand out by reason of their abundance in particular places or by their significance as indicator plants.

BARLEY GRASS (*Hordeum pratense*) and ROUGH BROME (*Bromus asper*) occur in great abundance—the former on the alluvium, the latter on the limestone soils, but they are not looked on with much favour as the Brome at least makes very poor hay.

Dog's Tail (*Cynosurus cristatus*) is very plentiful on various types of soil. It is useful on grazing land, as it makes its growth early in the year and provides good feed at this time. It is, however, of little use for hay. The leaves are short and die down early so that they escape the mower, and the flowering heads are tough and wiry and are disliked by cattle. They are familiar to everyone as even the sheep leave them alone, and they stand in thick array in fields and commons throughout the winter.

Meadow Foxtail (*Alopecurus pratensis*). This is an excellent pasture grass and is usually considered to be one of the most valuable of all for feeding purposes. Some farmers, though, do not think much of it for hay as it makes so much hard stem which is rejected by the animals. This criticism may apply to land on which the grass grows very luxuriantly, but perhaps is not so true where more ordinary growth is obtained.

Cocksfoot (*Dactylis glomerata*) provides good feed but it is apt to grow very coarsely, being specially encouraged by manure. In fields in which Cocksfoot is rampant it is necessary to apply manure very judiciously in order that this grass be not encouraged to the detriment of everything else.

Quaking Grass (*Briza media*). This is always a sign of poverty of soil and it disappears if the land is well fed, as it is apparently impatient of much competition and dies out as soon as other plants make really good growth.

Yorkshire Fog (*Holcus lanatus*) has a tendency to grow very strongly in some situations and to swamp other grasses, and in this state is not good for cattle on account of the woolliness of its leaves and stems. In the West Country it does not usually develop to this extent, though small plants about 9–12 inches high are abundant in some fields, but as they flower even in grazed pastures it looks as if the cattle neglect them in favour of more succulent food.

Vegetation of Special Areas.

In the course of a survey of grassland one thing gradually forces itself upon one's attention, *i.e.*, the marked effect that slight differences in level of soil or conditions of life has upon the herbage. Areas round gates and paths through fields are sharply marked out in this way, and they are characterised by a very definite type of vegetation.

Round the gates the soil is usually much trodden, so that its surface becomes more or less free from the ordinary grasses of the field. It often happens that this trodden soil becomes colonised

Fig. 4.—Plants common in trodden places.

A—Greater Plantain *(Plantago major).*
B—Silverweed *(Potentilla anserina).*
C—Rough Meadow-grass *(Poa trivialis).*

by certain weeds more usually found on arable land, such as Knotgrass (*Polygonum aviculare*), Swinecress (*Senebiera Coronopus*), Annual Meadow grass (*Poa annua*), May weed (*Matricaria inodora*), all plants that do not intrude into the general herbage. More generally the vegetation is still more characteristic. The grasses that do occur—largely Rough Meadow-grass (*Poa trivialis*) (Fig. 4 C), —frequently assume a prostrate habit. One plant is almost ubiquitous in such situations. Wherever a field is much trodden, there one is almost certain to find the Greater Plantain (*Plantago major*), (Fig. 4 A), and the more trodden the soil the finer the plant seems to grow. Paths are often demarcated by this plantain, and it appears even in places where not a vestige of it occurs in the regular herbage. Silverweed (*Potentilla anserina*) (Fig. 4 B) comes a very good second to the plantain, but is more apt to congregate round gates and cart tracks than along footpaths. Locally the Broad Dock (*Rumex obtusifolius*) and Creeping Thistle (*Cirsium arvense*) occur in abundance, and occasionally the Hoary Plantain (*Plantago media*) may be observed. In one instance at Falfield, where the path through a field was still green and not bare, it was colonised by a thick carpet of Daisy (*Bellis perennis*) and Dove's-foot Cranesbill (*Geranium molle*), but this was an exceptional case.

Wherever a *manure heap or stack* is placed in a field the grasses are more or less completely killed out and on the removal of the stack a bare area is left on which colonisation soon begins. The manure introduces various weed seeds, usually from arable fields, and such species as Knotgrass, Mouse-ear Chickweed, Fat Hen, Shepherd's Purse, Chickweed, Orache, Thyme-leaved Speedwell, Toadrush and Groundsel may usually be found. Here again the prostrate habit of the surviving grasses is noticeable. These may include Yorkshire Fog, Cocksfoot, and Ryegrass as well as Rough Meadow-grass, and of these the last-named is one of the first to resume the upright habit. The effect of a manure heap on the herbage that eventually clothes its site is very persistent. After 18 years, in one case at Tortworth Park, the position is still marked by the super-luxuriant growth of the grass, which lodges badly even when the rest of the field is not at all laid.

On the sites of *old ricks* arable weeds are not found, but strong growths of Broad Dock, Dandelions and Nettles are often seen, and these are sometimes surrounded by a ring of Cocksfoot associated with Sour Docks (*Rumex Acetosa*). Field Brome (*Bromus arvensis*) is also rather fond of such situations and was also found dominant at Berkeley on the site of an old heap of Grips (seconds lime) that had been spread on the ground.

Under the *shadow of trees* the herbage takes on a distinctive character, particular species growing in definite association. The three marked species are Cocksfoot, Foxtail and Rough Meadow-grass, but even these are divided amongst themselves. In the Gloucestershire fields Cocksfoot was to be found in abundance under almost every tree, sometimes dominating the situation, sometimes with either Foxtail or Rough Meadow grass sharing the pre-eminence. The density of shadow influences the distribution considerably. Under big trees, which cast very dense shade, it is usual to find Cocksfoot and Foxtail dominant towards the outer edge of the shade ring, whereas in the dense shadow near the bole they are replaced by Rough Meadow-grass and sometimes by Smooth Meadow-grass (*Poa pratensis*). Less frequently under big trees Rough Meadow-grass and Foxtail share dominance, with Cocksfoot only occurring occasionally.

In some cases, as at Hill and Berkeley, where the hedges are high enough to cast a real shade, resembling the partial shade under the smaller trees, Cocksfoot and Foxtail grow most luxuriantly along the edges of the fields, forming bands many feet broad which cease abruptly towards the edge of the shade line. Comparatively few other species occur at all under the shadow of trees, and usually only one or two of these are at all conspicuous in each instance. Tall and Bulbous Buttercups, Wild Chervil (*Anthriscus sylvestris*), Sharp Dock and Broad Dock, Sorrel, Pignut (*Conopodium denudatum*), and Field Brome practically sum up the colonists, though, in one instance at Cromhall, Creeping Thistle, Nettle and Ryegrass ventured as far as the outer edge of the shade circle.

Occasionally the vegetation under trees takes on a totally different character. Under certain trees in Tortworth Park *Bromus sterilis* absolutely dominated the situation, in some instances to the total exclusion of all other species, in others admitting Foxtail on sufferance. Under a very large oak tree on a mowing field, also at Tortworth, the deep shade was colonised by an abundance of Pignut, little else being evident except an undergrowth of grass. Further out, in the less dense shadow, Cat's Ear (*Hypochaeris radicata*) was dominant, very little Pignut being present. At the edge of the shade, merging into the main part of the field, the Cat's Ear was joined by masses of Moon Daisies, which also occurred in abundance out in the open, giving the field the appearance of a sheet of white and gold.

When fields are grazed by cattle, they are frequently scattered with clumps of coarse, luxuriant grass that the animals leave severely alone. These clumps spring up around the droppings, and are very

generally composed largely or entirely of Cocksfoot, with or without Sorrel in varying amount. The Cocksfoot is obviously much encouraged by manuring, and under favourable circumstances it will grow so strongly as to overpower nearly everything else. On this account care has to be used in the application of dung to certain fields where this grass flourishes. To some people the prevalence of Cocksfoot in clumps round the droppings and also under trees suggests that in the latter case the grass is encouraged by the fact that the animals seek the shade of trees during sunny weather, so that the ground there gets heavily manured, thus giving the Cocksfoot a grand opportunity. This may be true to a large extent, but even without heavy manuring Cocksfoot tends to grow very luxuriantly in the shade; indeed, in some parts of the world it is called Orchard grass because it forms the chief constituent of the herbage under the fruit trees.

The tussocks disfigure the fields and help to make the grass patchy. To keep them under it is well to follow after cattle with horses or sheep, as these have not the same objection to eating the grasses in the clumps.

FAIRY RINGS.

In some fields fairy rings are of frequent occurrence and may give some trouble by causing the grass to become very uneven in growth. The rings are formed by the action of various fungi which grow in a particular way and give rise to the characteristic appearance. The fungus consists essentially of long white threads called mycelium, which ramify and spread throughout the soil. At certain times this mycelium throws up fructifications, popularly called toadstools or puffballs. Usually these toadstools are of a medium size, 2–4 inches across, and of a fairly slight nature. Occasionally they are great hefty things 8–10 inches across, very solid and often of a dirty brown colour, especially when old.

The particular fungi which cause the ring start growing from a central point and ramify outwards in all directions, the fructifications being thrown up year after year on the outer edge of the ring, which grows bigger annually. The area which was occupied by the ring in the previous year seems to be particularly well manured by the remains of the fungus, as the grass grows very luxuriantly and is always of a very dark colour. The rings are marked out by their luxuriant growth and dark colour, even in mowing fields in which the grass is knee deep. In pastures they are always closely cropped, but are still characterised by their dark colour. After one year of heavy growth the transient stimulus seems to be exhausted, and the

herbage falls behind that of the rest of the field which is free from fairy rings, indicating that the ground has been seriously exhausted. The personnel of the herbage also changes. There is no fixed scheme of colonisation, as there is under the shadow of trees, but in each field the growth within and without the ring shows distinctive differences. Sometimes Yarrow (*Achillea millefolium*) and Rib-grass appear in the thick grass of the ring, though they are absent elsewhere: sometimes Cocksfoot is the chief grass in the ring, associated with a good deal of Hogweed. Another rather usual combination is Field Brome and Rough Meadowgrass, frequently combined with Sorrel and Cocksfoot. One very perfect ring at Wickwar consisted chiefly of Ryegrass and Cocksfoot. Within the ring the herbage was shorter and showed such a mixture of grasses and weeds as indicated poverty of soil. It included Vernal-grass (*Anthoxanthum odoratum*), Rough Meadow-grass, Dog's Tail, very little Cocksfoot and an abundance of weeds.

Too many fairy rings are not desirable in grassland, but unless they are so abundant as to threaten the herbage seriously it hardly pays to attempt to eradicate them. Liberal manuring will do much towards getting rid of them, but definite efforts at eradication are better reserved for lawns and special pieces of grassland.

IMPROVEMENT OF GRASSLAND.

Arable and grassland stand on somewhat different footings with regard to their improvement. It has always been fully realised that the crop obtained from plough land depends very largely upon cultivation and manuring and that the difference in results from year to year are not chiefly the effect of seasonal variation. Consequently close attention has been paid to the effective improvement of arable land, and artificial manures, since their introduction, have made considerable headway. Grassland is regarded from a somewhat different standpoint. The crop is not sown annually, it needs little "cultivation" and the treatment from time immemorial has been that of manuring by means of stock or by applications of farmyard manure. All variation has been attributed to seasonal effects, and too often little or no attempt has been made to turn a bad pasture into a useful one, or a good meadow into one that is excellent. Grassland farmers are much more conservative in this respect than arable farmers, but it is certain that a great deal could be effected by a judicious use of artificial fertilisers super-imposed upon the time-honoured methods of manuring, which provide the essential basis for all schemes of improvement.

The artificial manure that is probably needed most universally in the districts visited is lime or chalk. Grassland is never disturbed, so that it is never exposed to the sweetening influences of air and frost. It is clothed with a thick mat of vegetation, the roots ramifying in a dense mass throughout the surface soil, the shoots interlacing into a felted mat which shelters the ground from the purifying action of the sun. In the course of growth the innumerable plants utilise much of the reserves of plant food, of which the land is robbed when the grass is cut for hay or eaten by stock. Much is returned in the form of manure, but little of the lime finds its way back from this source. In the course of years the lime is slowly leached out and carried away by drainage, so that the land gradually becomes more and more sour. Further, parts of the vegetation are constantly dying and decaying and the decomposition products contribute their quota to the increasing sourness or acidity of the soil. These effects are more marked in some cases than in others. Some of the soils visited, as the Mountain Limestone, Marlstone and Inferior Oolite, contain a great reserve of lime, but others, as Alluvium and Peat have comparatively little in their composition, so that the effects of shortage are exhibited more quickly in the latter case. With increasing acidity the herbage begins to suffer. The quantity of growth gets less and the quality of the grass depreciates. Some of the most valuable pasture plants are very impatient of sour land and they decrease in quantity and may even die out if the soil becomes very acid. Thus freed from competition other less valuable grasses, such as Vernal-grass and Yorkshire Fog, increase rapidly until they swamp everything else. With due application of lime this depreciation can be arrested and improvement brought about. This improvement is not only shown by the increase in crop and in the amount of valuable grasses, but also by the more healthy colour of the herbage. On acid soil this is a light yellowish green, indicating that the vital processes of the plant are not acting at maximum pressure. Where plenty of lime is present the grasses are a good dark colour. At Rothamsted a number of pots were filled with an acid soil to which varying quantities of lime were added, and similar mixtures of grass seeds were sown in each. The results are very marked. Different species flourish in varying degrees according to the amount of lime present, and the colour of the grass grades regularly from light yellowish green in the most acid pot to a dark healthy green in those pots which received a full and adequate dressing of lime.

Much of the pasture land in Gloucestershire, as at Cromhall, Wickwar, and Tortworth, lies over the Mountain Limestone, and

it is usually said locally that land in this situation cannot be lacking in lime. This is a fallacy, and probably some of this land is very deficient. The leaching by rain, the robbing of the land by haying and grazing are constantly going on, and as the surface soil is gradually depleted there is no automatic replacement from the vast stores in the limestone rock beneath. It is possible, as occurs on the chalk downs in Wiltshire, to have a layer of surface soil so acid that the most typical indicators of acid soil, Sheep's Sorrel and Spurrey, grow in abundance on the arable land. The very handiness of the material necessary for replacement tends to blind the farmer to the need for using it, but the good results that have followed where it has been applied indicate the possibilities that lie in the freer use of lime.

Another substance that often has a good effect on herbage is phosphate. It is comparatively seldom that grass land needs potash so badly when sufficient natural manure is supplied by stocking or by applications of farmyard manure, but it is often found that the soil answers well to phosphate, applied either as superphosphate or basic slag. On some of the Mountain Limestone soils, as at Tortworth and Cromhall, and on those derived from the New Red Sandstone, as at Williton, experience has shown that superphosphate is the effective agent, slag proving useless. Only field experiments will decide definitely which of the two to use, as the land varies so greatly within very short distances. and while one part of a farm may need superphosphate another may respond better to slag. As a general rule it will be found that basic slag is the more useful manure. Wherever there is a shortage of lime it is useless to apply superphosphate, but the slag provides phosphate and also the lime necessary to sweeten the soil and to enable the phosphate to do its work. Slag is specially useful on strong clay land such as occurs on the alluvial flats at Berkeley and Dunster, and it is also said to be useful on the Coal Measures near Cromhall.

The behaviour of the animals is in itself an indication of the increased value of the herbage when artificial manures have been applied. Where slag has been used cattle will eat the grass down to the ground, whereas in places to which it has not been applied they pick and choose very unevenly. At Carhampton one field received slag along a wide strip down the middle. When the horses were turned out they invariably sought this strip every night, eating and sleeping on it. The next year the whole field was slagged, but still the animals showed a marked preference for the strip which had received the double dressing.

The cleansing effects of lime are very marked in some instances where the land has received special treatment. A rough pasture at Chedzoy, on peaty clay, was once spread heavily with cesspool cleanings which made the land foul. It was afterwards sweetened by a heavy dressing of lime, and since then animals turned in will always feed by preference on this part of the field, and they do really well on it.

Though lime, superphosphate and basic slag may be regarded as the standard essentials, over and above dung and stock manuring, other forms of fertiliser are often very effective, but this is not the place to enter into this question.

VIII.—THE POSITION AND PROSPECTS OF MOUNTAIN AND MOORLAND PONIES.

By T. F. Dale.

Our native breeds of ponies have in the last few years come to their own. The improvement in the various breeds of our mountain and moorland ponies has kept pace with their growing estimation among horse-loving people. The game of polo drew public attention to the possibilities of our native ponies. The quality, the handiness, the courage, and the docility of the polo pony were attributed, quite rightly, to the strong infusion of pony blood present in the majority of them. The virtues of ponies had hitherto been known to the individuals who owned them, but their importance in a national scheme of horse breeding was not realised. There were, indeed, men who saw the possibilities of the pony and who recognised that our native breeds of ponies were necessary to the improvement of our light horses. Mr. Runciman's committee, of which Lord Arthur Cecil was chairman, produced a report showing, beyond all possibility of contradiction, how much pony blood had counted for in the evolution not only of the polo pony but of the hunter, the racehorse, and the hackney. It was shown that all English light horses were a blend of pony, Eastern, and English blood in different proportions according to the purpose for which the breed was required.

Their importance as foundation stock consists in the self reliance, resourcefulness, hardihood and intelligence which the wild life of these mountain and moorland ponies has made necessary to their survival. Thus it was seen that the value of the pony as a

factor in horse breeding was most marked in those herds of ponies which led a free life on the Welsh Hills, on Exmoor, on Dartmoor, or amid the milder climate but poorer pastures of the New Forest. The ponies might be small,—the average mountain and moorland pony is seldom much above 12 hands, and often less. Ragged they might be to look at, disfigured by hardship or neglect, but the indomitable spirit was there and also the potentiality of growth under more favourable conditions so that the rough pony from Wales or Dartmoor could be in one generation improved into a polo pony or a small hunter. It also soon became clear that while the mode of life of the native breeds might limit their height, they were capable of great improvement, while some of the defects which spoil the looks of many ponies could be removed by a little care. There were too few stallions with the breeding herds; those that were running were poor in quality, and many herds needed fresh blood. I think the first object lesson of what could be done was given us by the Longmynd Pony Association. They took off the hills the unsuitable stallions, and eliminated inferior stock. They were speedily rewarded by an immense improvement in the make and shape of their ponies and by a not less welcome increase both in the demand for them and in the prices that they obtained for them in the market. To-day these ponies, though small, are of fine quality, and have most excellent bone and good action.

The movement once begun spread rapidly. Many local associations were formed for the improvement of ponies. In Wales the Commons Act was put in force on the Eppynt Hills, on the Penybont Commons, and on the Gower Peninsula. The adoption of the Commons Act was the condition on which the Board of Agriculture granted premiums for stallions. The Board also recognised the principle that our native breeds ought not to obtain out-crosses by the introduction of alien blood, but by careful selection within the limits of the breed; if an out-cross is needed it should be sought from one of the other mountain and moorland breeds and not from outside sources. The result of the application of the Commons Act was to ensure that selected stallions ran with herds from which old, diseased, or otherwise unsuitable mares had been eliminated. In Wales, where the commons and hills on which the ponies run are often separated by a considerable stretch of cultivated country, it is easy to find fresh blood without departing from the limits of the Welsh mountain breed, which is one of the best native breeds in England when kept pure, and, with the possible exception of the Exmoor, is the best foundation stock for hunters or polo ponies. It is my experience that the purer a breed is,

that is the more the herds are confined to their own sort and type, the more valuable the pony mares are for the improvement of other breeds when crossed with larger animals. This produce of native pony mares is later on transmitted by various channels to the light horses of the country.

A great step forward was made when the Polo and Riding Pony Society extended its work and became not only in name but in reality a National Pony Society. Since then no year has passed without something being done by the society for the improvement of native ponies and the encouragement of their breeders. Perhaps the best instance of this was the institution in 1916 of the group class for three or more native ponies, on the suggestion of Mr. Herbert Pratt, a member of the Council. A prize of £10 was offered for the best group, and was afterwards increased to £20 by the generosity of two members of the Council. This prize brought out typical groups of fell, Highland, New Forest, Exmoor, Dartmoor, and Welsh ponies. The fell pony group won, and the stallion of this group carried off the "Country life" trophy. The chief benefit of this fine exhibition was that it showed the public the ponies at their best, and yet in nearly every case in natural condition. Then again the ponies received a valuable testimony when Lord Selborne's Committee affirmed the value of the pony in national light horse breeding, quoting with approval the report of Mr. Runciman's Pony Committee.

It is a fortunate circumstance that the environment of our native ponies is so strong an influence in preserving the type that even where a breed, as in the case of the Dartmoor, has to a certain extent been corrupted by the injudicious introduction of alien blood, or has been neglected, as was the case in the New Forest, care in the selection of stallions will not fail to restore the type and quality of the breed. This was very notable in the Dartmoors shown in the group classes at Islington by the Prince of Wales in the Spring of 1916. These were typical Dartmoors. In the same class there was a group of Sir Thomas Acland's beautiful Exmoor ponies, which have been kept jealously free from any alien cross. It is, perhaps, not generally known what a number of good hunters and polo ponies are bred round about Exmoor, and what courage and constitution the pony infusion from this source produces. There is another characteristic of the Exmoor breed which is, that it does a great deal of work on small rations of grain. It is quite surprising how little corn ponies and cobs with the Exmoor strain require. Indeed, if over-fed they soon get above themselves.

It is, however, quite interesting to note how, when fine qualities

are latent in any pony race they re-appear, even after a long period of neglect. There is probably no breed which has now more good individual ponies of various types than the New Forest. If the 60,000 or so of acres over which the forest ponies range necessarily cause the types to be varied in different parts of the forest, the variation is chiefly in size. One quality all Forest ponies have in common is their action. The old Forest pony was always noted for its pace, and was in old days famous for its exploits in the country races, which were, and still are (though to a less degree), popular in the West. These race meetings still survive in the races for Forest ponies, which form an attractive finish to the annual show at Burley. There is to be seen a pony which still retains the courage, resolution and dash of the old Forest racing-ponies. This pony, "Duster," on ordinary days, draws a milk cart; on the show day he competes (often successfully) in jumping competitions, and at least two scurries. The Forest pony is a natural jumper.

To these good qualities the commoner ponies have in recent years added a great improvement in looks. There is no breed which has had more outside, but not alien, blood brought in than the New Forest. In 1886 there was a re-infusion of eastern blood, of which there are still notable traces in the Forest. Lord Arthur Cecil introduced some Highland blood; this, however, has not been altogether successful. He also brought in some of the old "Knight" strain from Exmoor, and some Dartmoor blood. Lord Lucas has introduced a good deal of Welsh blood and some Exmoor stallions, which have been very useful. The point which is most notable is the ease with which the Forest mares absorb and assimilate these out-crosses, for the young stock in the second generation invariably revert to the old Forest type, losing, however, some of the characteristic faults. These were, probably, the result of neglect and the toleration of inferior stallions and mares in the forest. Had the Commons Act been applicable to the New Forest, or had the verderers exercised with more resolution their undoubted powers, the progress of improvement would have been far more rapid. Nevertheless, the societies and associations and the New Forest Commoners have done a great deal, by the judicious expenditure of money on prizes and premiums, to improve the quality, and, incidentally, the market price of their ponies. The Board of Agriculture gives every year ten premiums, and a number of reserve cards for ponies to be turned out on the Forest to run with the herds. To meet this liberality the Burley Pony Society distributes premiums to the best mares and fillies every year, so that it may be made worth while for owners to keep some of their best for breeding purposes. Thus a number

of the best mares, and not as formerly the worst, run over the Forest year in and year out, getting their own livelihood and storing up those pony qualities of which I have written.

The following points are those which experience has shown most effectually assist in the improvement of the pony:—

(1) That the wild herds shall live their own life in their native haunts with the least possible interference from man.

(2) That there should be careful selection within the limits of the breed, out-crosses to be used but sparingly, and then only where needed.

(3) That the most valuable of qualities are purity of race and unbroken pedigree.

(4) That selection should, where possible, include a stern elimination of the inferior ponies, and especially the removal of badly shaped stallions or infirm mares.

(5) That every effort should be made to retain the pick of the fillies with the wild herds and that it should be clearly understood that hardihood and good looks are correlated, so that the best shaped ponies thrive in their native haunts. The opposite opinion, that the uglier a pony the hardier he is likely to be, has been held and has almost amounted to a conviction, but facts and market prices are gradually getting rid of this misapprehension.

(6) That it is useless to attempt to increase the height of ponies intended to run out on mountains or moorland. Nature has decided within certain limits the best height for a pony in the Welsh and other districts; this can always be increased by better feeding and more shelter in the case of young ponies taken away at an early age.

Thus it will be seen that the best methods for improving our native ponies can be ascertained with tolerable certainty. The evidence of the pony shows tells us of improvement year by year. There is, I believe, scarcely any limit to the possibilities of the pony if the best stallions and mares, always of true pony blood, be used.

The services of ponies in the war give them another claim on our attention. To quote but a few instances, Captain F. O. Grenfell's polo ponies, Lord Middleton's Highland ponies, the Dartmoor pack ponies in Gallipoli, will occur to everyone as a few instances out of many that might be brought forward. Perhaps the most

striking facts are the work done and the endurance shown by those hunters which have been drawn from the pony districts and had in them pony blood. Great as is the work of which ponies are capable, yet their chief value lies in the invaluable strains of pony blood which are, from the reservoirs of the wild breeds, distributed by various channels to the great invigoration of all breeds of light horses.

IX.—THE FARMER AND THE LIVING PLANT.

By S. Leonard Bastin.

In a certain sense every successful farmer is a scientific man. Knowledge is needful in order to satisfactorily carry out the most trivial of the numerous duties of the agriculturist. Every person of intelligence plans his practice upon theory, and in this way the scientific outlook of the average farmer is by no means to be despised. Even though he has had small opportunity of studying physiology, chemistry, and physics, yet he can draw upon a vast store of information in all these directions. Indeed, were it not so, his efforts would end in failure. This practical knowledge that the agriculturist gathers almost in the doing of his work is not, however, by any means, the complete story. There is always a danger that the busy man will forget the value of theory. It is perhaps natural, for instance, that he should rather look down upon the investigator who spends a vast amount of time studying the life histories of plants. In many cases there is nothing very startling to show for all the labour expended, yet these patient workers are gradually unravelling the mysteries that surround the life of the plant. Everything that is discovered makes it clear that our knowledge of the living plant cannot be too comprehensive. Even the most elementary facts may, with profit, be considered again and again, so that the meaning of every phase of life may be understood. In the present paper the writer proposes to trace the life of the plant from start to finish, emphasising most of all those points that are of special interest to the agriculturist.

THE BEGINNING OF THE STORY.

In the embryo (Fig. 1) of every seed we have an organism that is capable, under proper conditions, of developing into a plant. Certain

requirements are needful if the germination of the seed is to take place. First of all the question of temperature may be considered. Practically all the common agricultural plants of Britain will show a healthy and speedy germination where the temperature ranges from 55° to 70° F. The effect of a low temperature is to retard the starting of the seed and this may be a positive advantage; otherwise the baby plant may appear on the scene when the atmospheric conditions are too inclement for a proper growth. It is commonly found that the late starters make the best plants. It has been observed that the temperature at which the germination of the seed takes place has an effect upon the form of the plant. Where germination is associated with a temperature at or near to the minimum, the production of new roots, buds and leaves is retarded. As against this, the germination of a seed at a relatively high temperature tends to bring about a rapid formation of fresh roots and leaves even before those present in the germ have been fully developed. The outcome of this may be that the plant tends, in a popular phrase, "to overgrow its strength." Thus, practically for all plants there is an ideal temperature for the germination of the seed. In this connection it is well to bear in mind that the temperature of the land can, to an extent, be controlled. Badly drained land and that which is unduly heavy is relatively cold. After drainage, an appreciable warming up of the soil is evident.

A certain amount of moisture is needful if the seed is to germinate. The absorption of water is a prelude to the various changes that take place in the germ cells. A comparatively small amount of dampness is sufficient, seeing that seeds take up moisture very readily. On the other hand an excess of water may be very harmful and, if such a state of affairs continues, the seeds will be in danger of rotting.

Germinating seeds must have air. During the early stages of activity a great deal of oxygen, which is one of the constituents of the air, is required. A few germinating seeds of any kind if placed in a stoppered bottle with a little moisture will soon exhaust the oxygen. This can be proved after a few days, by plunging a lighted match into the bottle, when the light instantly goes out. (Fig. 3.)

It is not true, as is sometimes stated, that light is harmful to germination. A strong light tends to retard the growth of plants but there is nothing to show that the actual germination of the seed is hampered in any way by light. In this connection, we may remember that in nature enormous numbers of seeds are

hardly covered at all, save perhaps by a few drifting leaves. This brings us to the all-important question of the depth at which seeds should be sown. The burying of seeds sown in a garden or field serves the purpose of hiding them from birds, etc., and also prevents them from drying up. Very extensive experiments in temperate regions all over the world show that the seeds of all farm crops germinate best when sown at between one and three inches deep. It pays however in all cases to consider the character of the soil which is being cultivated. Where the ground is very light and porous quite deep sowing may be carried out with excellent results. Thus, in a very sandy soil, peas have been sown at a depth of six or eight inches without suffering in any way. When buried in this manner the seeds were quite safe from the attacks of birds and mice. In well worked or light soil the air (which we must remember is so essential for germination) is found at a much greater depth than is the case with heavy ground that is not well broken up.

THE BABY PLANT.

Following on the germination of the seed the little plant grows upwards. Into the light and air goes the shoot and downwards into the soil pushes the root. Many attempts have been made to discover the real cause of this downward growth of the root. We have to fall back upon the statement that the radicle of the young plant has a geotropic (earthward) tendency; but this is in no way an explanation of a remarkable phenomenon. An interesting experiment to show the rapidity with which the radicle of the seedling will turn towards the earth if it is placed in a horizontal position is illustrated in Figs. 4 and 5. Seeing that all the food which the plant takes in from the soil is absorbed by the roots, these organs are worthy of a detailed consideration. At first we would point out that it is a mistake to suppose that all the underground parts of a plant are roots. The tubers of the potato and artichoke are not roots at all, but simply underground stems. These, and most underground stems, are readily distinguished from roots owing to the fact that they bear buds, *e.g.*, the "eyes" of the potato. A limited number of plants, such as the plum, apple, pear and hawthorn are able to send up shoots from their roots. Thus it is possible to propagate these trees by means of root cuttings. In a general way, the real roots of plants do not bud off and the specimen will die if the stem is completely severed. The stem of the little plants rapidly extends upwards. At this point it is interesting to note the part played by the cotyledons. The seeds of the

flowering plants are divided into two great classes—the dicotyledons or two-seed-leaved, and the monocotyledons or one-seed-leaved. The monocotyledons are chiefly represented by the grasses, the lilies, and the palms. The difference between a Bean (dicotyledon) and Maize (monocotyledon) may be briefly summarised.

BEANS.	MAIZE.
Two fleshy cotyledons surround the embryo.	Only one cotyledon surrounds the embryo.
Food is stored in the young plant.	Food is stored outside the young plant.
The whole of the seed inside the seed coat and papery lining is the germ.	The germ constitutes only a part of the seed.
The veins of the leaves form a net-work.	The veins of the leaves are parallel.

Compare the development of the bean plant with that of maize. (Figs. 6 and 7). In the former the two cotyledons are so obviously part of the plant that they come up, turn green, and act the part of leaves eventually. This does not happen in the case of all dicotyledons however, for the cotyledons of the acorn, for instance, remain below the soil though they are plainly attached to the stem. Note the sharp point of the shoot of the maize which, protected by a sheath, pushes upwards through the soil. This manner of development is typical of the monocotyledons.

THE ROOTS OF THE PLANT.

The dicotyledons may be yet further distinguished from the monocotyledons by their roots. The former have at first a solitary descending axis, which penetrates vertically into the ground. This is called a tap-root, and, from this central organ the lateral roots branch out at more or less regular intervals. This tap-root is of immense importance to the farmer in that its upper part (under cultivation) has developed into the fleshy nutritive mass to be found in the turnip, beet, carrot, etc. In the case of the monocotyledons the descending radicle is not prolonged into a tap-root, but quantities of lateral roots are given off from the base of the young plant. As

the plant grows the roots, especially in the case of dicotyledons, may attain to a considerable size. But, as a rule, the most important part of the root is slender. It is through the extremities of the thread-like processes that the food is absorbed. The actual tip of most roots is found to consist of cells which have become detached from the organ. These combined together form a kind of cap that plays a useful part in protecting the root as it pushes its way through the soil. The cell tissue which has the power of absorption begins a little way back from the tip, and practically all parts of the young roots of plants are continually engaged in taking up material from the soil. In a very large number of cases the young roots of plants are covered with minute hairs. (Fig. 2.) These simply represent the out-growth of advanced cells, and it is by means of these that the food material in solution in the soil is taken up. When one considers the delicate nature of the youngest, and therefore most active, roots of the plant, the importance of a friable soil is realised. The way in which plants will hold on during a long drought in a light soil is often a matter for wonder. This is due to the fact that the nature of the soil permits a very widespread growth on the part of the rootlets. Thus the actual absorbent surface exposed is very great indeed and such plants may really secure more moisture than those growing in a closer soil where the roots cannot spread so easily. The use of explosives in farming for breaking up the soil particles is valuable owing to the fact that, after treatment, the maximum amount of root activity is possible on the part of the crops. In many cases the downward extension of roots is checked by what an American farmer will call the "hardpan." This is a close layer of soil below the reach of a plough into which the roots of the crops cannot penetrate. Break this up with dynamite and the most astonishing results are secured. In this connection it is interesting to notice the frequent comments of soldiers in the present war on the luxuriance of weed growth on the battle fields. There is little doubt that this is the direct result of the high explosive shell, the force of which breaks up the soil into the smallest particles.

HOW THE PLANTS TAKE FOOD FROM THE SOIL.

When in an active state of growth plants are continually taking up liquid from the soil. If on a sunny day you cover a plant with a glass jar, in an hour or so it is seen that the inside of the jar is covered with drops of moisture. This water has been given off (transpired) by the plant in the form of vapour which has condensed on the glass surface. Any thriving plant is always transpiring a

large amount of moisture and this loss can only be made good by that which is taken up by the roots. In the spring of the year when a plant is in a vigorous state of growth the water moves upwards with considerable force. Some experiments have been conducted with a vine of which the stem was cut right across. (Figs. 8, 9, 10.) Over the cut end a piece of bladder was tied. As can be seen by a glance at the illustrations, this bladder was fully distended in an hour, whilst not long afterwards it burst, quite unable to withstand the pressure of the rising sap. Now all the food material which the plant takes in from the soil is absorbed in a state of solution. At a later stage it will be needful to enquire into the nature of the substances which are required by the plant, but at present we may rest content with the statement that they are chiefly mineral salts. These salts are present in the thin film of water that surrounds the particles of which soil is composed. We must remember that these soil particles are in close contact with cells in the roots of the plant. The principle by means of which the root hairs take up the solution from the soil has been clearly demonstrated by numerous experiments. One of the simplest is the following. A wide-mouthed jar is secured and this is filled right up with a moderately strong solution of sugar and water; a piece of bladder is then tied over the mouth of the jar. It is important that the jar should be quite full so that there are no air bubbles. Then the jar is immersed in a bucket of plain water. After a day it is taken out and examined. The membrane which stretched across the mouth of the jar has become very tight and there is also a pronounced bulge outwards. It is as though the sugar in the jar had attracted water to it through the bladder. At the end of a few days it is found that the water in the bucket is sweet. Without a doubt some of the sugar solution has passed outwards through the membrane into the water. This passage of water one way and sugar the other will go on until there is *an equal strength of sugar solution* on both sides of the membrane. This principle known as osmosis (from the Greek osmos, an impulse or pushing) is the method followed by the plant in order to secure its supply of food material from the soil. The root hair is simply an extension of one of the outermost cells of the root. Under a microscope it is seen to be formed of a delicate wall of cellulose; inside this there is a thin layer of protoplasm or living matter. The interior of the root hair is filled with sap. This sap is of an acid nature which has a great attraction for water. These acid substances have been produced by the protoplasm of the cell, and it is entirely due to their powers that water is attracted to the cell. These substances in the sap of the cell act in a manner similar

to that observed in the case of the sugar in the jar. Finally the cell becomes so distended with sap that it contains more sap than the cell lying next to it. The liquid passes through the cell wall into the next cell and so on until the whole of the soft outer cells are distended. The innermost of these cells adjoin the water-conducting tissue of the plant and when their distention reaches a certain point the sap is allowed to escape into the water-conducting region. This region is continuous with the stem and leaves of the plant. After the escape of the sap the cells become flaccid but they soon fill up again and the discharge of sap is repeated. Thus we have a kind of pumping movement which accounts for the uprush of sap so graphically illustrated in the case of the cut vine-stem.

It must always be borne in mind that the ultimate outcome of osmosis is to equalise the strength of the solution on either side of the membrane. That was why the water went in one direction through the bladder and the sugar in another. Bearing this in mind we may consider the following points in connection with root absorption :—

(1) Certain of the attractive acid substances in the sap come out into the soil from the roots because they are not present in the soil.

(2) Water enters the root hair from the soil carrying in solution mineral substances which do not happen to be present in the sap.

An interesting way to prove that acids come from the roots of plants is the following. Grow a plant in a flower pot at the bottom of which a piece of smooth marble has been placed. After a month or so an examination shows that the plan of the roots has been etched on the marble by the solvent action of the acids they have given out. It is known that these acids help the roots by rendering some minerals soluble that would otherwise be insoluble. Mineral substances of any kind in solution will pass into the root-hair if there be more of them in the soil-water than in the cell of the root-hair. This absorption will go forward until the solution in the root-hair is exactly the same strength as that of the water covering the soil particles. If the minerals thus taken up by the roots are not freely used by the plant there comes a time when the absorption of these particular substances ceases. The cells of the plant are saturated with this material; then the inward flow from the soil lessens and may stop altogether. On the other hand, with substances that are quickly used up it is obvious that the cells are

always in a more or less impoverished condition and the in-drawing of the matter goes on continually.

It is well that the farmer should always bear in mind the way in which plants take up their food from the soil. A new light is shed upon the whole question of applied fertilisers when some of the points raised are fully considered. Obviously it is useless to load a soil with substances that a particular plant does not greatly require. Even with the more helpful materials it is of no use to enrich the ground to an excessive degree. The plants cannot take up a given material more quickly than they can use it.

WHAT PLANTS TAKE FROM THE SOIL.

A plant is composed both of organic and inorganic matter. The former will constitute about 95 per cent. of the whole plant and the latter about 5 per cent. These figures vary a little in different plants. The organic matter of plants consists of protoplasm (the living part of the plant), woody fibre, cellulose, starch, sugar, gum, oils, fats, albumin, glutin, globulin and legumin. All these items are manufactured by the plant in the wonderful leaf factories that are described on a later page. The inorganic material in the plant consists of silica, lime, potash, soda, ammonia, magnesia, in addition to hydrochloric, phosphoric, carbonic and sulphuric acids. Other chemical substances are occasionally found in the plant, but these are probably there by accident. Ash represents the inorganic chemicals taken up in solution by the growing plant from the soil. The organic parts of the plant are formed of carbon, hydrogen, oxygen, nitrogen, sulphur, and small amounts of phosphorus. The organic constituents which contain nitrogen are called nitrogenous. Those composed of carbon, hydrogen and oxygen are spoken of as non-nitrogenous. Nitrogenous substances in the plant include vegetable albumin, glutin and legumin; non-nitrogenous matters are represented by such constituents as starch, sugar and gum. The percentage of any of these elements varies greatly in different plants and also in different parts of the plants. Thus it has been shown that 1,000lbs. of dried wheat contain :—

461lbs. of carbon.
434lbs. of oxygen.
58lbs. of hydrogen.
23lbs. of nitrogen.
24lbs. of ash.

The same weight of wheat straw would contain :—

484lbs. of carbon.
390lbs. of oxygen.
53lbs. of hydrogen.
3lbs. of nitrogen.
70lbs. of ash.

The nitrogenous constituents of the plant may be shortly described :—

GLUTIN.—This is a sticky substance present in the seeds of wheat and other cereals.

GLOBULIN.—This is largely found in seeds and it often gives rise to albumin. It forms one of the group of nitrogenous constituents which are insoluble in water but soluble in dilute solutions of such salts as sodium chloride, magnesium sulphate, etc.

VEGETABLE ALBUMIN.—This is met with in all parts of the plant, but it is most of all present in the seeds and roots. The albumins, both of animal and vegetable origin, belong to the group of nitrogenous substances characterised by their solubility in water.

LEGUMIN.—This is a substance like casein in cheese, and it is found in the seeds of leguminous plants.

The non-nitrogenous organic compounds in the plant may be roughly classified :—

WOODY FIBRE.—This material forms the hard parts of the plants to be found in the branches, stones of fruits, seeds, etc.

CELLULOSE.—This is a substance akin to starch. It occurs in the walls of all plant cells, and is found in a pure form in the woolly fibre that surrounds the cotton seeds. Cellulose is highly characteristic of plant life, since it is scarcely ever present in the animal organism. The most notable exception is furnished by the quaint marine creatures known as "sea squirts" (Ascidians), whose outer tunic, or cuticle, is largely composed of it.

STARCH.—This is almost the most important substance to be found in the plant, and it occurs practically in every part. It is easily transformed into sugar, in which form it is carried about the plant. The formation of starch is dealt with at a later stage.

GUM, RESINS, WAX, ETC.—These substances occur in different parts of the plant and are often of great value to mankind.

We must bear in mind that all the foregoing organic substances are manufactured by the plant out of the elements taken in from the soil and air. To discover the nature of the inorganic parts of the plant a chemical analysis is necessary after the burning of a known weight of material. It was a common idea a few years ago that by analysing the ash of any kind of plant it was possible to show definitely the sort of food required by that plant. This has been shown to be a mistaken idea for, as we have already seen, the cells of plants may become charged with substances for which the plant has no use at all. Experience teaches us that the most fruitful source of enquiry is that in which test crops are grown with certain fertilisers and the results carefully watched.

WHAT WATER CULTURES SHOW.

The system of water cultures has made it possible to find out much concerning the essential elements for the growing plant. One or two experiments may be indicated here, but these must not be taken as representing the whole series. Wide-mouthed jars are employed and these should be well cleansed by washing with dilute nitric acid and then rinsing with water. The number of jars required will depend upon the number of solutions with which it is proposed to experiment. The mouth of each jar should be completely covered with a cardboard disc, in the centre of which a hole is made, large enough to accommodate the stem of a growing seedling. Seedlings of any common hardy plant may be used. The following is a full culture solution :—

Potassium nitrate	...	1 gramme.
Sodium chloride	...	·5 ,,
Calcium sulphate	...	·5 ,,
Magnesium sulphate	...	·5 ,,
Calcium phosphate	...	·5 ,,

A few drops of iron chloride solution may be added. These ingredients are dissolved in a litre* of water (distilled) and boiled for about half an hour. When cool, place in the glass jar and fix up the seedling plant so that its roots are in the solution. Sterilised cotton wool may be placed round the hole in the cardboard where the stem of the plant is. Also cover the outside of the jar with

* A measure of capacity in the metric system, the unit being the millilitre. Roughly speaking, the litre is nearly equal to 1¾ imperial pints.

opaque paper. These precautions discourage the growth of vegetable moulds and other minute organisms that are often a great nuisance in experiments of this nature. The culture solution should be changed every ten days or so. Most plants, it will be found, go on growing well in such a solution, producing leaves and flowers much on the same lines as they do in the soil. Other seedlings may be set up in jars filled with solutions from which certain of the chemicals above-mentioned are omitted. Thus :

Sodium can be omitted by using potassium chloride instead of sodium chloride.

Chlorides can be omitted by employing sodium sulphate instead of sodium chloride.

In both these cases no very marked change will be found in the growth of the plants. The plants suffer very seriously however when—

Nitrates are omitted by using potassium sulphate instead of potassium nitrate.

In such a case growth is almost at a standstill. Retarded development is also to be observed when either calcium, potassium, phosphates, or sulphates are omitted from the culture solution. In order to institute a strictly accurate comparison, it is necessary that the plants growing in the several solutions should all be exposed to the same conditions of light, air, temperature, etc.

The effect of a series of experiments with culture solutions is to show that for all practical purposes the chief mineral plant foods are the nitrates, phosphates, and potash. To a lesser degree calcium and the sulphates are needful. One may briefly consider the parts played by the three chief foods.

Nitrates bring about a vigorous growth of the whole plant. Where the soil is exceptionally rich in nitrogenous matter there is a tendency on the part of crops to produce quantities of leafage.

Phosphates are chiefly concerned with the production of fruit and the early maturity of crops as a whole.

Potash increases the quality of the fruit. This element also has the power of stimulating the production of starch or sugar.

There is no need to lay stress on the importance to the farmer of such points as these.

MOST PLANT FOODS IN ORDINARY SOIL.

In the average soil there is a sufficiency of phosphates, potash, and the other elements needed by the plant. In the case of phosphates and potash these substances may not be very readily available. The natural phosphates are extremely slow in action. To make potash of service, the application of lime or chalk is sometimes needful. Still it is not common to find a soil that is seriously lacking in these elements. This cannot be said in the case of nitrates, of which the soil may be depleted to a serious degree. It has been shown that the nitrates in the soil are largely the result of bacterial action. Even when nitrogenous manure is added to the ground it must first be changed into nitrates before it is available for use by the plant. Nitrogen is known to be abundant in the atmosphere, but the plant cannot obtain this element direct from the air. It has been shown that lightning in its passage through the atmosphere acts in such a way that the nitrogen combines with the oxygen. The compound formed is dissolved by the rain, and this is carried to the soil where it is available for use by the plant. In the soil itself a very important part is played by the leguminous plants. Clover, peas, beans, etc., have on their roots swellings or tubercles. (Fig. 11.) These are the homes of hosts of bacteria having the power of fixing within themselves the nitrogen present in the air or in the soil. When these colonies of bacteria die out the fixed nitrogen is available for use by the plant. This is the reason why after digging in the roots of leguminous plants, the soil becomes richer in nitrates than it was before. The rotation of crops in which leguminous plants play such an important part dates from a period long prior to that in which the nature of the tubercles on the roots was understood. Without a doubt the inoculation of soils with the beneficial kinds of bacteria is on the right lines. The matter is still in its infancy, but it may be positively said that in the case of leguminous crops it is possible to bring about an increase in the number of tubercles on the roots by inoculation. In this way the power of fixing the nitrogen from the air in the soil is greatly increased.

WHAT THE PLANTS TAKE FROM THE AIR.

We have been able to realise, to a small extent at any rate, some of the wonderful work carried on by the roots of the plant. Even the briefest description of plant life would be quite incomplete without a consideration of the part played by the green leaves. Air is a mixture of gases, chiefly nitrogen, oxygen, carbon dioxide,

Fig 1. - French Bean split open and enlarged to show embryo and cotyledons.

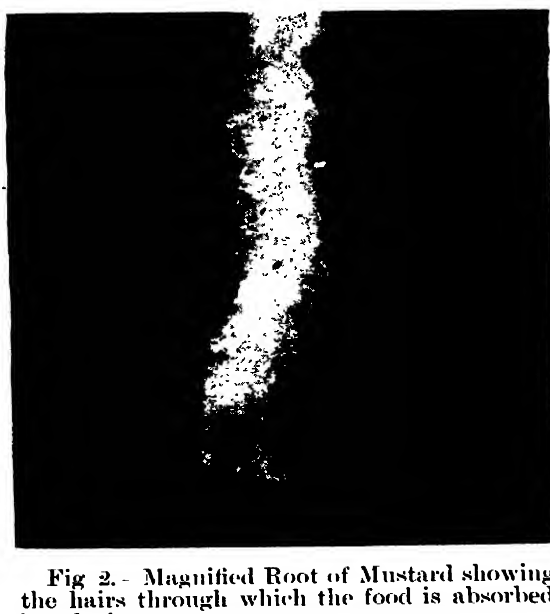


Fig 2. - Magnified Root of Mustard showing the hairs through which the food is absorbed in solution.

H

Fig 3.—The oxygen in the jar is exhausted by the germinating seeds—hence the lighted match is extinguished.

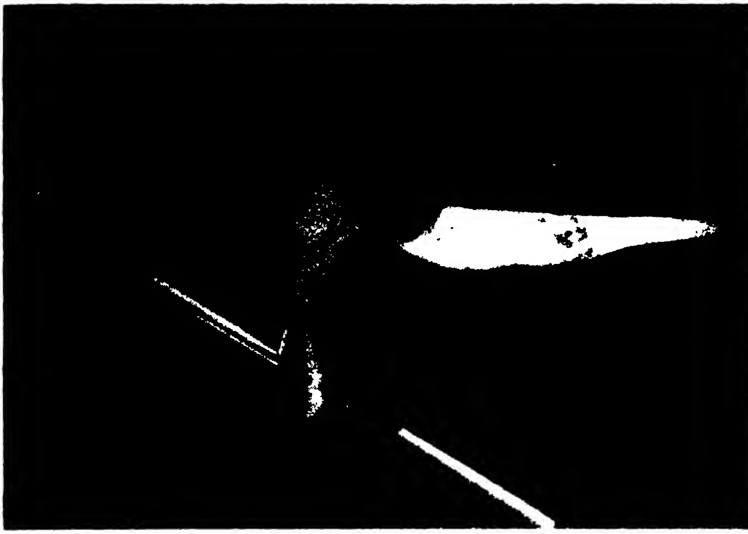


Fig. 4.—Enlarged picture of Bean with radicle in horizontal position.

Fig 5.—Twenty-four hours later. The radicle has turned downwards.

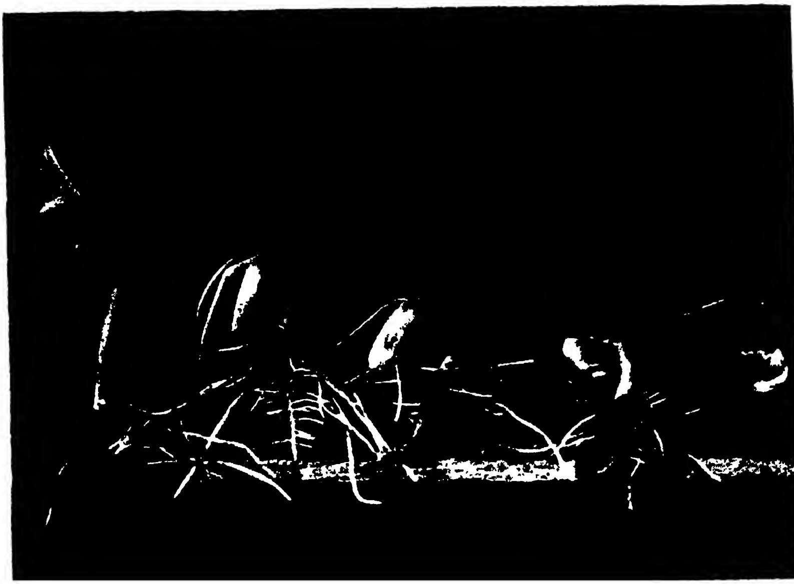


Fig 6. -How a Bean develops into a plant.

Fig 7.—How a Maize grain develops into a plant.

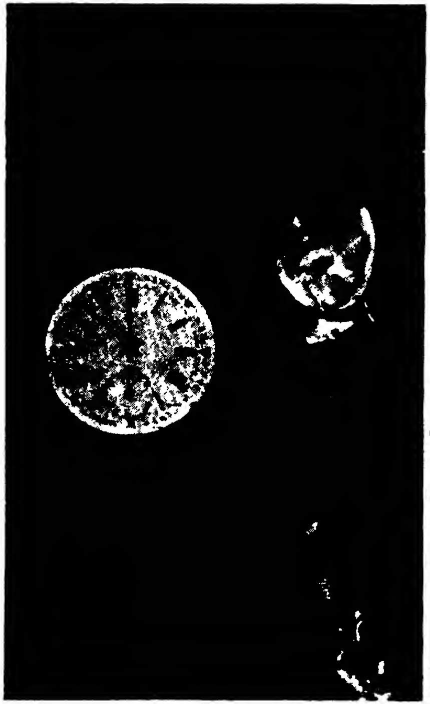


Fig 8.—A piece of bladder is tied over the cut stem of a Vine.

Fig 9.—Two hours later the bladder is completely distended full of sap.

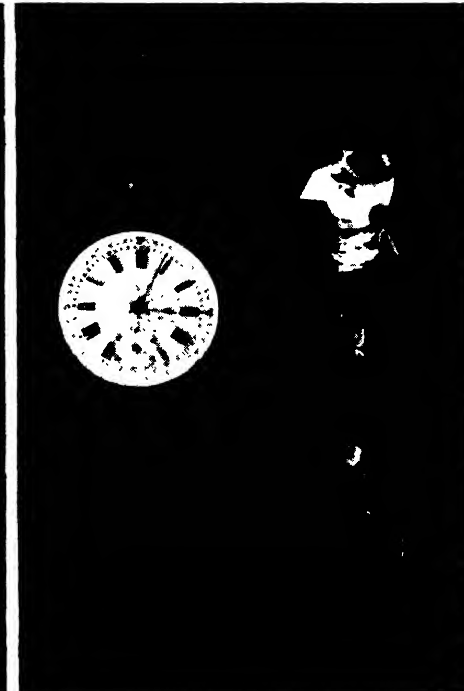


Fig 10. Three hours later the bladder bursts, unable to withstand the great pressure of the sap.

Fig 11.—The nodules on the roots of a leguminous plant.

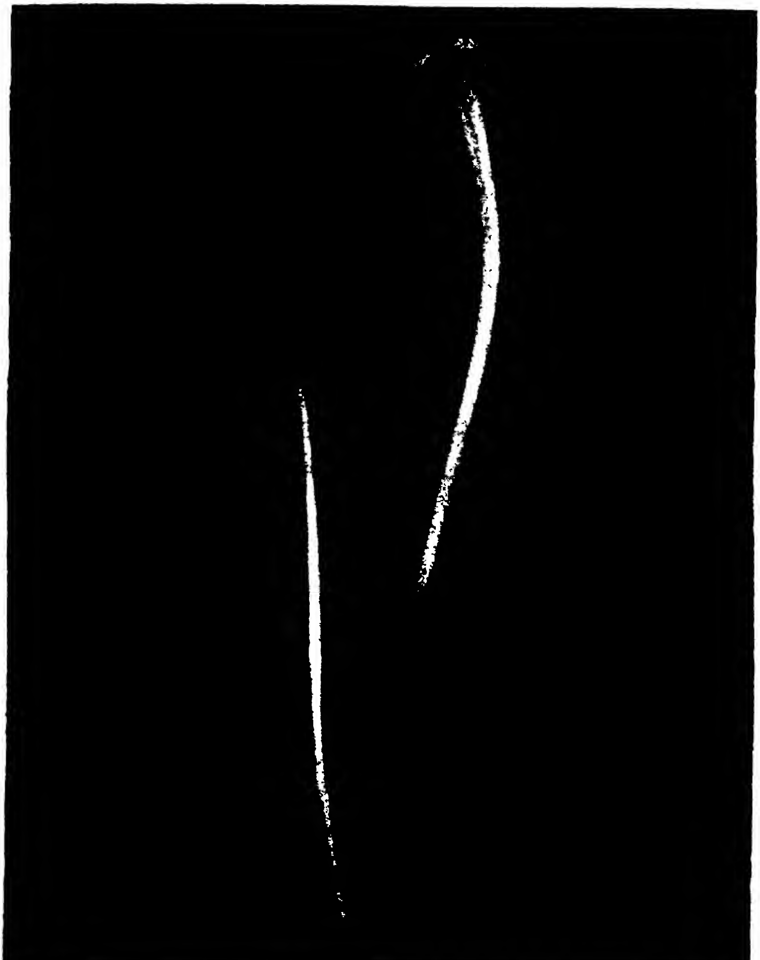


Fig 12.—Stamen and carpels (together forming the "pistil") of a Lily.

and an amount of water vapour. In the first place it must be remembered that plants really breathe, though in a very different way from animals. That is, they take in oxygen and give out carbon dioxide. This respiration goes on at night as well as during the day and it is evidenced in all parts of the plant. The breathing of the plant involves the breaking down of protoplasm, and there must be a building up of fresh living matter to make good the waste. This is accomplished by assimilation. Perhaps this process is the most remarkable in the life of the plant. Unlike respiration it goes forward only in sunlight and does not occur save in the green parts of the plant. In the cells of the plant are to be observed numerous green bodies of an oval or spherical shape. These are the chloroplasts without which the plant would be quite unable to manufacture sugar or starch. The colouring matter is due to the presence of tiny granules of a green pigment called chlorophyll. Light is essential for the formation of chlorophyll. Plants kept in darkness are of a sickly green colour. A sufficiently high temperature and a certain amount of iron are also necessary if the green colouring matter is to appear. The formation of starch goes forward only in connection with chlorophyll. One or two simple experiments may be carried out to fix this point in the mind. The test for starch in a leaf is as follows. Gather a leaf from a tree at the close of a warm summer's day. Boil it in water until it is flabby, and then soak for a time in warm methylated spirit. It is then seen that the chlorophyll is quite soluble, for the green matter washes away from the leaf leaving it a pale yellow colour. If the leaf is now soaked in a solution of iodine it will turn a dark bluish colour. This change of colour is a well-known indication of the presence of starch. If this experiment is carried out in the case of a leaf from which the light has been excluded (and which is consequently lacking in chlorophyll) no change of colour occurs. In this case it is clear that no starch is present. Other conditions are also essential for the formation of starch in the leaves of the plant. Leaves smeared with vaseline, so that the air is kept away for some hours, show if tested, that they have not been making starch. During cold weather starch is only formed to a small extent.

The green leaves can be proved to be making the starch out of the carbonic acid gas of the air. A plant is placed with a few sticks of caustic potash under a bell glass; the caustic potash absorbs the carbonic acid gas from the air. However well lighted this plant may be there is no formation of starch. But given carbonic acid gas, sunlight, and a suitable temperature the formation of starch goes forward in the leaf without ceasing. The chlorophyll

of the leaf cells has the power of separating the carbon from the carbon dioxide, thus releasing the oxygen. The starch in the leaf is built up from carbon and water; the latter is taken in by the roots as we have already seen. All the other organic substances in the plant are made in these wonderful leaf factories. In this production, the elements which we know the plant takes up from the soil are used. Plants make complex organic matter by utilising the energy of the sun's rays. This material either directly or indirectly forms the food of the entire animal kingdom, for all animals live by destroying organic matter. Thus plants carry on a vital work as far as the world is concerned.

What happens to the Starch in the Leaf.

After the manufacture of starch in the leaf, the substance undergoes a subtle change by means of which it is altered into sugar. Thus in the very early morning a leaf that is tested for starch will give little or no signs of it. That which was made on the previous day has been changed into sugar and has already been distributed about the plant. The sugar passes into various parts of the plant but especially into the seeds, tubers, etc. Here it is reconverted into starch in which form it will keep for an indefinite period. Seeds, tubers, and the like may thus be regarded as the chief storehouses of the plant.

The Growth of the Plant.

In our review of the life of the plant we have seen how the chemical processes going on may be grouped under two heads. First, there is that wonderful building up of complex substances from simple elements known as assimilation. Secondly there is the breaking up of protoplasm which is always going on in living cells, ending in the giving out of carbon dioxide. This latter process, as we have already noted, is practically analogous to the respiration of animals. Now when the building up of the substances exceeds the breaking down of materials, the phenomenon of growth takes place. In a living plant the materials of growth are water, free oxygen, and food both from the soil and air. Temperature has a marked effect upon the rapidity of growth. In a comparatively high temperature both of soil and air the development of the plant is much more rapid than where there is a lack of warmth. All plants that live for more than a year have resting periods. In temperate regions

this resting season generally coincides with the winter. At this time the climatic conditions are not favourable for active growth and the plants pass into a quiescent state. In a leafless tree during the winter there is very little going on. Transpiration has practically ceased, sap movements are so slight as to be hardly noticeable and the tree is as near dead as a living thing can be. Then comes the spring, and, as if by the touch of a magic hand, all is altered. The roots begin to take up moisture and a vigorous upward flow of sap commences. The buds burst open and the green leaves are displayed. Once again the wonderful work of the green cells of the plant is started.

THE REPRODUCTION OF PLANTS.

Sooner or later the question of reproduction arises. The method of reproduction followed by plants may be of two kinds, vegetative or sexual. In the former instance, creeping or swollen stems produce an increase of the kind. The common couch grasses reproduce to an astonishing degree by means of their creeping stems from which buds arise at intervals. The tuber of the potato is a swollen stem covered with buds any one of which will give rise to a new plant. It may be pointed out that plants produced in this way can hardly be called fresh individuals seeing that they are alike in all respects to the parent. New individuals arise when a plant is reproduced by the sexual method. In such a case the union of two germs of life takes place in order to form one—the embryo of the seed. However worn out the parent may be, this embryo gives rise to a plant having the full vigour of life. In any flower the essential parts are the stamens and the carpels. (Fig. 12.) On the anthers of the former are to be found little bags containing the pollen grains or microspores. On the carpels are the ovules, each of which contains one large spore the macrospore. The plan of reproduction consists in the fusion of one of the male cells with one of the female cells. But before this *fertilisation*, as it is called, takes place there must be pollination. The pollen from the anthers must be transferred to the tip of the ovary. The point at which the pollen grain adheres to the ovary wall is the stigma ; this has a rough sticky surface that is of use in detaining the grains. A secretion of a sugary nature stimulates the growth of a tube from the pollen grain. This grows down towards the ovary and carries out the process of fertilisation. Many are the means adopted to carry the pollen grains to the stigmatic surface in the various kinds of plants. These plans are particularly

interesting in the case of cross pollination, that is where the pollen is conveyed from one flower to another. In such cases, insects and the wind play an important part as agents for the carrying of the pollen. When the fusion of the male cell with the female has been brought about the ovary ultimately develops into a seed, and the ovary or carpels into the fruit wall or seed vessel. Thus the story of the plant is brought to a conclusion.

X.—TELLING THE AGE OF EGGS.*

By S. Leonard Bastin.

Nowadays, when so many folk are interested in poultry keeping, it is well to know how easy it is to tell the exact age of an egg. Most people know that in the thicker end of each egg there is an air space. As the days pass by this space increases in size owing to the fact that moisture from the egg evaporates through the pores of the shell. This loss of density makes it possible to arrive at the age of any egg by specific gravity. In the first place a solution of salt and water is prepared, one part of the former to two parts of the latter being allowed. The egg behaves in this liquid according to its age. Any time up to thirty-six hours from the laying of the egg it will sink in the salt solution and lie horizontally on the bottom of the vessel. When two or three days old, the egg rises near to the surface and floats with a small portion clear of the water. There is to be noted a tendency on the part of the thick end (where the air space is) to rise upwards. As the days go by this tendency increases progressively. In eggs of four or five days old the long axis (an imaginary line drawn through the centre lengthwise) is at an angle of 20° from the perpendicular. At the end of the eighth day it is 45°; on the fourteenth day 60°; on the twenty-first day 75°, whilst in four weeks the egg will be standing quite upright in the liquid. To show clearly the angles at which the egg is floating is easily done. A card is prepared with a scale of degrees ranging from 0° to 90°, the latter representing the perpendicular. If the eggs to be tested are placed in a glass jar the scale of degrees can be held behind and, in this way, a good idea is obtained of the angle at which they are floating. (*See illustrations.*)

---

* This method was described (without illustrations) in the Note Book section of last year's *Journal*, p. 199-200.

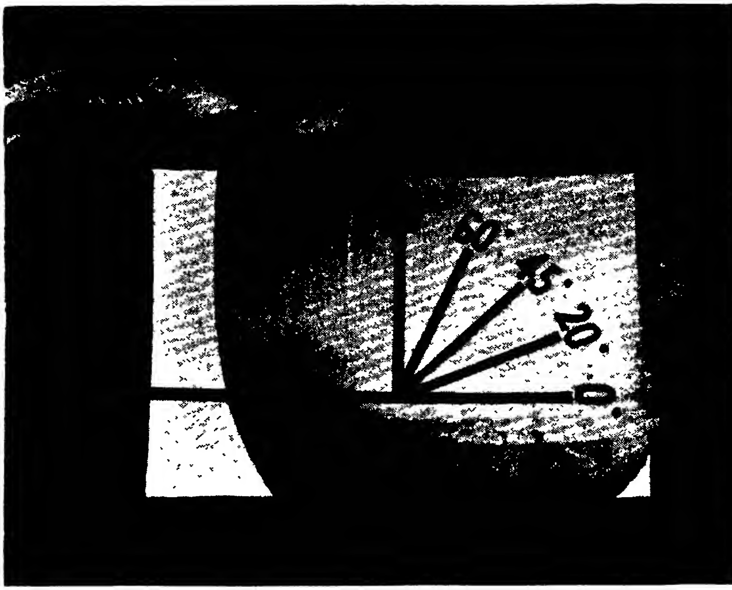


Fig 1.—The glass vessel containing a brine solution. The angle at which the egg floats determines its age. An egg under 36 hours sinks to the bottom.

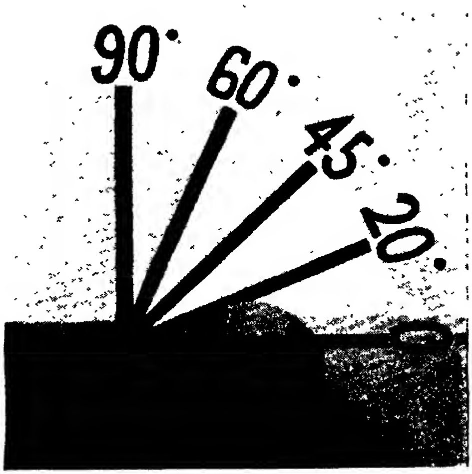


Fig 2.—An egg from two to three days' old floats horizontally just below the surface.

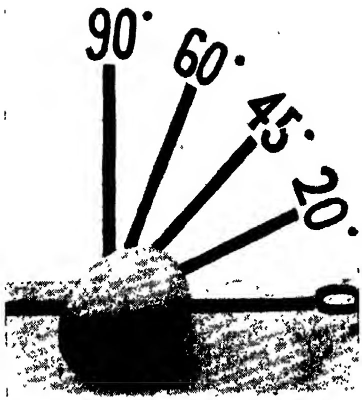


Fig 3.—At the fifth day an egg floats at an angle of 20°.

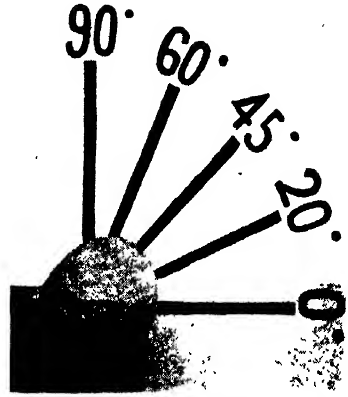


Fig 4.—On the eighth day the egg floats at an angle of 45°.

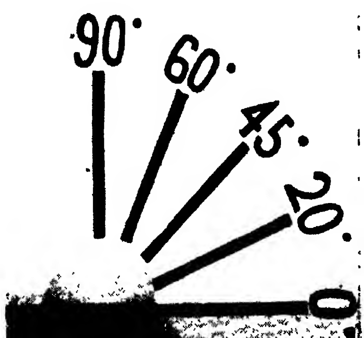


Fig 5.—On the 14th day the egg floats at an angle of 60°.

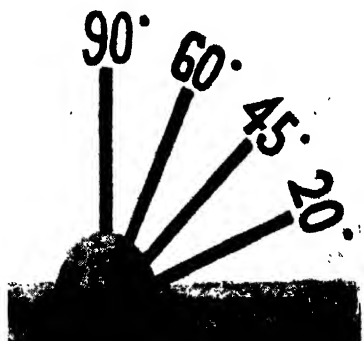


Fig 6.—At the end of four weeks the egg stands upright in the solution.

XI.—ANNUAL REPORT UPON THE SOCIETY'S GENERAL OPERATIONS.

By Thos. F. Plowman, Secretary and Editor.

Owing to the impossibility of holding the Society's Annual Show in 1916, the Annual General Meeting of Members was held on Thursday, July 27th, in the G.W.R. Board Room, Bristol.

In the unavoidable absence of the President (the Earl of Coventry), Mr. C. L. F. Edwards, Vice-President, was voted to the Chair, and there were also present Mr. J. D. Allen, Vice-President; Sir H. H. A. Hoare, Bart., Col. the Hon. C. Byng, Rev. A. T. Boscawen, Dr. E. C. Ashford, Major A. H. Gibbs, Messrs. W. H. Clark, J. E. Daw, R. A. Fox, J. T. Gibson, G. Lipscomb, G. Martyn, F. F. Mason, M. St. J. Maule, H. B. Napier, G. Nichols, A. F. Somerville, C. C. Tudway, Thos. F. Plowman, Secretary and Editor; etc.

Communications from members regretting inability to be present, in many cases owing to Military duties, were read.

The minutes of the previous Annual General Meeting having been read and confirmed, the Chairman mentioned that during the last few days the sad news had been received of the death, in action, of the eldest son of their Consulting Chemist, Dr. J. A. Voelcker. He was quite sure that the members would desire that the Secretary should convey to Dr. Voelcker the sincere regret with which the Meeting had received the intimation, and their deep sympathy with him and his family in their bereavement, and this was agreed to. The Chairman said that they were also sorry to learn of the recent death of Mr. T. L. Kirkham, of Perdiswell Hall, Worcester, who was the occupier of the site on which last year's Show was held, and with whom the Society had had most pleasant relations. He had since then most kindly permitted the Society's plant to be temporarily housed in his park pending future arrangements. The Meeting, on the suggestion of the Chairman, directed the Secretary to convey their regret and sympathy to Mrs. Kirkham and family.

The Chairman moved, Mr. H. B. Napier seconded, and it was resolved, that Mr. G. E. Lloyd Baker be elected a Vice-President of the Society, and that the sincere thanks of the Society be conveyed to him for the devotion he had shown to its interests, and the way in which he had upheld its best traditions.

On the motion of Dr. Ashford, seconded by Mr. J. D. Allen, the gentlemen named on page *viii* of the Appendix to this volume, were elected Members of Council for the years 1916–18.

The accompanying Report, which had been adopted at a meeting of the Council held that day, was then submitted to the meeting :—

"The Council present their Annual Report to the Members under circumstances without a parallel in the long history of the Society.

"For the first time for 64 years, it has been found impossible for the Society to hold a Show. The reasons for this have been so fully set forth in the last volume of the Society's Annual Journal, issued to every member, that it is unnecessary to enter into them here. In view of the fact that the nation and its allies are waging the greatest war the world has ever had the misfortune to experience, the Society could not hope to escape some of the disabilities under which every section of the community is suffering.

"For the present, the Show Plant is being housed on the site of last year's Show at Worcester, and the Council desire to express their indebtedness to the occupier, Mrs. T. L. Kirkham, of Perdiswell Hall, for her courtesy in permitting this.

"The Council earnestly trust that national events may soon shape themselves in such a way as to permit the holding of the next Show at Salisbury, as arranged previous to the outbreak of war. Meanwhile the Council would welcome any suggestions from members with regard to other suitable cities or towns desirous of receiving the Society, in the event of the military position of Salisbury rendering a further postponement of the holding of the Show there necessary.

"The Council desire to express the Society's indebtedness to Lord Coventry for kindly consenting, in accordance with the wish of the last Annual General Meeting of Members, to continue to act as President until the Society is in a position to decide upon its future action with respect to the Show.

"The Council regret that during the past year death has deprived the Society of an old and valued member in the person of the Earl of Jersey, for many years one of its Vice-Presidents, who filled the office of President in 1878 with much distinction, and was a generous contributor to its funds. They have also to lament the loss of their friend and colleague, Major C. D. Sherston, a staunch upholder of the Society's best traditions, who for long had identified himself with its work and had rendered essential service for several years as a Steward of Horses. A former member of Council, the Hon. John Boscawen, whose sterling qualities and good comradeship endeared him to all with whom he was associated, has also passed away.

"An extraordinary vacancy in the Without Reference to District Division of the Council has been filled by the election of the Hon. C. B. Portman.

"The Council recommend that Mr. G. E. Lloyd Baker be elected

a Vice-President of the Society, and that the gentlemen named on the Agenda Paper of the General Meeting, being all retiring members willing to serve again, be re-elected members of Council for the years 1916–1918, but that, in view of the absence of many members of the Society on military service, the filling up of other vacancies be deferred for the present.

"The Council have re-appointed Mr. W. Ashcroft upon the Governing Body of the South-Eastern Agricultural College, Wye, and Mr. A. R. White, upon the Board of Governors of Dauntsey School Foundation; both members being representatives of the Society whose term of office had expired.

"The necessity, in view of the present shortage of farm-hands, of encouraging the manufacture and use of labour-saving implements and machinery, led the Council to endeavour to organise a demonstration of Motor Ploughs and Tractors within the area of the Society's operations. After conferring with all the leading firms who make a speciality of such machines, the Council reluctantly came to the conclusion that, owing to the fact that most of the firms were fully occupied in munition-work and also that their staffs were very much depleted through recruiting, it was impossible to proceed further in the matter.

"The Council have continued the Annual grant of £100 to the National Fruit and Cider Institute in the full belief of the value of its work. The Institute, the establishment of which was due to the practical and scientific research work initiated in 1893 and conducted until 1902, conjointly by the Society and the Board of Agriculture, at Butleigh, under the direction of Mr. F. J. Lloyd, F.C.S., is now attached to Bristol University. Experimental and research work is being actively carried on at the Institute, which there is every reason to believe is of essential service to those engaged in cider-making and fruit-growing. An arrangement has been made under which members of the Society can obtain from the Institute, free of charge, analyses of cider apples and perry pears.

"The Institute has also undertaken to distribute to the Society, or to persons nominated by it, free of charge, a selection of trees which have been worked with the best varieties of cider apples and perry pears, and has conferred upon the Society the privilege of nominating, free of all fees, one student for a course of instruction in the theory and practice of fruit-growing, cider-making, etc., to be held by the Institute at the University of Bristol.

"With a view to assisting farmers and others in dealing with insect and other pests which affect agriculture, horticulture, etc., the Council have availed themselves of an offer from the Board of

Economic Biology of the University of Bristol, to investigate the nature of any insect or other pest and report upon it free of charge.

"For many years the Annual General Meeting of Members has been held in the Society's Show Yard. This being impossible on the present occasion, the Council thought that the convenience of the members generally would be best met by holding it at Bristol on a market-day.

"The Council unitedly join in the fervent hope that the blessings of peace may ere long be restored to the world, thus enabling the Society to resume its full activities. It seems abundantly clear that, on the conclusion of the War, such help as agricultural organisations can render will be more than ever needed; and it must be a matter of serious consideration as to how such associations can best aid the important national industry they represent. In the meantime, the Council earnestly urge upon the members and all who have the welfare of this work at heart, the necessity of a continuance of the support hitherto accorded to the Society. In order to fit it to resume its full services to Agriculture, it is incumbent upon it to maintain its organisation intact, so that it may be in a position to deal at once with such problems as may arise upon the much-desired advent of an enduring peace."

The adoption of the Report was moved by Col. the Hon. C. Byng, seconded by Sir H. H. A. Hoare, and agreed to.

The Chairman said that before separating, he was sure that the General Meeting would desire to follow the example of the Council and express their great pleasure at having the Secretary there and their congratulations to him upon his improved health, and that this be entered upon the minutes.

The Secretary having responded, the meeting terminated.

XII.—THE NATIONAL FRUIT AND CIDER INSTITUTE.

By Professor B. T. P. Barker, M.A.

The work of the Station was maintained under considerable difficulties during 1916. At the outbreak of the war most of the labour staff joined the Army and the available supply of suitable substitutes has been very limited. The dearth of labour has been somewhat relieved by the employment of women in the fruit plantations. So far as the lighter work is concerned they have proved useful, but the heavier work has suffered. The staff changes

have necessitated the simplification and curtailment of the experimental work in the plantations as far as possible, and the keeping of crop records and similar statistics has been reduced to a minimum.

Mr. J. Coombes, who has held the position of fruit foreman since 1907, was transferred early in the year to the post of pomologist, and has since been called up for military service. His place as fruit foreman has been filled by the appointment of Mr. H. Locke, who has had extensive previous experience both of commercial fruit and vegetable culture and of nursery work.

In the cider house staff rearrangements have also been necessary. The regular cider-maker rejoined the Army at the start of the war and his successor was called up last spring under the Derby scheme. Mr. E. P. West, the Secretary-Manager of the Station, has temporarily taken charge of the practical cider-making.

As regards the scientific staff, Dr. Lechmere is still interned in Germany. Mr. C. T. Gimingham, the Chemist of the Station and Adviser in Agricultural Chemistry for the Bristol Province, has been granted leave of absence for special war work, and Mr. W. Camps, the head laboratory assistant, is undertaking the analytical work while he is away.

That the work of the Station has not suffered to the extent which might have been anticipated is due to the manner in which members of the staff have striven to meet the emergency by undertaking additional duties.

The report of the work now presented forms only an incomplete record of the year's activities. For the most part the accounts of the investigations included have been condensed as far as possible: and reference to several subjects has been entirely withheld, where this has seemed advisable, until the time is more opportune for the publication of detailed descriptions. Practically the whole of the statistical matter, including that relating to the composition of vintage fruit for the 1915 and 1916 seasons and the various records of the fruit trials and experiments, has been omitted, the only exception being in the case of the composition of the single variety ciders examined in the season of 1915–16.

The demonstration of Belgian methods of vegetable culture conducted by M. Savoye, which was begun in June, 1915, was continued until the end of the past summer. It aroused considerable interest among market gardeners in the district and has afforded an opportunity of estimating the possibilities of the system under prevailing conditions in this country. Broadly speaking, the general conclusion to be drawn seems to be that there are two essentials

required for financial success, viz., an abundant supply of cheap labour and ample farmyard manure at low cost, neither of which conditions obtain here under normal circumstances. Certain cultural methods and types of vegetables were introduced which it will be interesting to test in due course under more favourable conditions: but, on the whole, it is doubtful if the English market gardener will find it profitable to modify his prevailing methods to any considerable extent, unless radical changes occur in the normal economic conditions of the country.

Since the development of the Station in 1912 a large number of trees have been raised in the nursery for the extension of the experimental work in fruit culture. But for the intervention of the war new plantations would already have been established with these; but this work was postponed on that account as long as possible. Since it is now imperative that the trees should be planted in their permanent positions without further delay, additional land, 10¾ acres in extent, adjoining the existing cider bush plantation, has recently been acquired. It has now been broken up and, after the trees have been planted, will be mainly intercropped with various food crops until the end of the war, when the place of the latter will be taken by small fruit.

In addition to research work of the usual character a number of questions which have arisen as the result of existing conditions brought about by the war have been investigated.

For example, as a part of a general scheme now in progress at various Research Stations throughout the country, an examination of the ash of bracken foliage grown in the surrounding district has been begun with a view to the use of this material as a possible source of potash.

Several problems which have been encountered during the course of the work on fruit and vegetable preserving at the factories established by the Board of Agriculture at Dunnington Heath and Broom Junction have been referred to the Station for investigation.

Special attention has been given during the year to the use of various forms of glucose as partial or complete substitutes for cane sugar in jam-making.

Further experiments have been made with cider fruit and cider apple pomace with the object of finding methods of utilising these materials for food purposes to gain full benefit from the substances of food value which they contain. In the course of this Report accounts will be found of experiments carried out at Seale-Hayne College by Mr. B. N. Wale, B.Sc., in which the food value of those articles for live stock was tested, and also of others conducted at

Long Ashton, which have resulted in finding a method for utilising cider fruit of all kinds for table purposes.

An investigation on the manurial value of various local waste organic products found in certain parts of Somerset has been continued in conjunction with Mr. J. H. Burton, M.Sc., the Agricultural Organiser for that county.

The individual sections of the Report have been contributed as follows :—

Single Variety Ciders and Perries, 1915–16 : by B. T. P. Barker and O. Grove.

The Pasteurization of Bottled Ciders : by O. Grove.

The Influence of Temperature and Acidity upon the Cider Sickness Bacillus : by O. Grove.

Trials with a Hydraulic Press for Cider Making : by O. Grove.

New Trial Cider and Perry Orchards, 1916–17 : by B. T. P. Barker.

A Black Rot of Apples : by G. T. Spinks.

A Spot Disease of Apples : by G. T. Spinks.

A Root Rot of Black Currants : by G. T. Spinks.

Reversion of Black Currants : by A. H. Lees.

Further Experiments on Big Bud Mite : by A. H. Lees.

Miscellaneous Notes on Plant Pests : by A. H. Lees.

Experiments on the Treatment of Rhizoctonia Disease of Asparagus : by B. T. P. Barker and C. T. Gimingham.

Leaf Scorch of Apples : by B. T. P. Barker and C. T. Gimingham.

Factors Governing Fruit-bud Formation : by B. T. P. Barker and A. H. Lees.

Soil Influence on Strawberries : by C. T. Gimingham.

Miscellaneous Notes on Experiments in Fruit Culture : by B. T. P. Barker, A. H. Lees and G. T. Spinks.

Cider Fruit for Table Use : by B. T. P. Barker.

Experiments on the Value of Cider Fruit and Pomace as Stock Food : by B. T. P. Barker and B. N. Wale.

The Use of Glucose in Jam Making : by O. Grove.

INVESTIGATIONS ON CIDER.

Single Variety Ciders and Perries, 1915–16.

In the table given below will be found a list of the ciders and perries made during the season 1915–16, giving the chemical composition and other particulars. The usual notes upon the character of the individual samples are omitted this year.

Taken generally, the ciders were rather thinner than usual, the average specific gravity of the juices being only 1·0486, which is below the normal. As an example of an exceptionally low gravity can be mentioned the case of Red Foxwhelp, which was only 1·037. The average gravity of the pear juices was rather higher, viz., 1·052.

Sharp Varieties.—The best types in this group were Bell, Ponsford, Old Foxwhelp, Never Blight, Cap of Liberty and Red Soldier, which were very good ciders, especially for the first six months. Later the Cap of Liberty, Never Blight and Old Foxwhelp deteriorated somewhat in flavour. No. 6, Lambrook Pippin, had a pleasant aroma, and was otherwise good. No. 7, Ramping Taurus, was a good cider with a characteristic flavour. No. 8 had a peculiar flavour reminiscent of cooked apples; this flavour grew more pronounced as the cider was kept. Nos. 9, 11 and 12 were all fairly good sharp ciders, the last-named with a very penetrating acidity. No. 16, Woodsell, had a pleasant acid flavour, but was rather lacking in character. Nos. 17 and 18 had both a clean brisk flavour.

In the Kingston Black group the most interesting samples were 27*a*–27*e*. The three samples, 27*c*, 27*d* and 27*e*, were decidedly superior to 27*a* and 27*b*. These three samples had all been fermented at a higher temperature (12–15°C.), *d* and *e* fermented with pure yeast, and *e* pasteurized at 50°C. for one hour before fermentation. In the case of this last sample there was no cooked flavour at all; not with 27*b*, which was also pasteurized and pure yeast added, but fermented in the cider house at a lower temperature. The three casks kept at the higher temperature naturally fermented quicker than the casks kept in the cider house, where the temperature sometimes is very low during the fermentation season. Of the other Kingston Black ciders Nos. 26, 30 and 32*a* were quite good, better than the rest but somewhat below the standard of the variety. No. 32*c* had a nice full flavour, but the pasteurization could easily be detected, as it had been carried out at a rather high temperature (60°C.).

Sweet Varieties.—Of this group the two first were rather inferior. Of the Eggleton Styres the pasteurized sample, fermented with pure yeast, was superior to the control. No. 37*a* was fairly good during the first six months but developed later an unpleasant flavour. This was not the case with 37*b*; the washing with formalin may have had a beneficial influence. The Slack-ma-Girdle was quite a good representative of the variety. No. 38, a new apple in these trials, gave a very pleasant cider with a clean flavour and good aroma.

Of the Sweet Alford series the three first, kept at room temperature (12–15°C.) during fermentation, fermented, as would be expected, quicker than the rest and were ready for filtering three weeks after the making. They were the best of the whole series, especially 40*c*, which was pasteurized, pure yeast added, and kept at 12–15°C. during fermentation. It kept its good character very well and was, when tasted after being about one year in bottle, superior in flavour, aroma and keeping quality to any of the others. It was also clearer than 40*a* and 40*b*. No. 40*e*, also pasteurized and the same pure yeast added but kept at a lower temperature, fermented very slowly and was not ready for filtering until over 2½ months after 40*c*; it was quite inferior to 40*c*. 40*f*, fermented with two gallons of lees per hogshead, was rather inferior, and 40*g*, fermented with four gallons of lees per hogshead, went sick three months after filtering and turned ropy later. 40*h*, which had been saturated with CO_2 before fermentation, did not show any special character. The two last samples treated with sulphur dioxide had a slight sulphured flavour during the first five or six months. This flavour had very nearly disappeared after twelve months in bottle, and both the samples were quite good. 40*g* was the only sample that went sick during the summer. No. 41*a*, Ansell, gave quite a good cider with an aromatic but rather musty flavour.

Bitter-sweet Varieties.—The first three, 41, 42 and 43, were fairly good ciders, but the last two did not keep well and were very poor in flavour after being about twelve months in bottle. No. 44 was a very fine cider in the early stages, *i.e.* for the first six months, but deteriorated later. Nos. 45, 46, 47 and 48, were all fairly good ciders with a clean bitter flavour and kept well. No. 49 was practically a sweet cider with no bitterness; it improved by keeping and was very good after being bottled for eleven months. Of the remaining bittersweets Nos. 52 and 54 were the best, with good body and a pleasant bitter flavour. No. 54 went sick later in the season.

Perry.—Of the perries none were of special merit. The three Oldfields, Nos. 63, 64 and 65, were the best, all rather similar, with a very pleasant brisk and clean flavour. No. 57 went sick quite early. No. 58 was rather too acid in flavour and developed a peculiar mousey flavour later. No. 59 was rather coarse in character: No. 60 quite good, but thin. Nos. 61 and 62 were good when young, but kept rather badly; 61 especially was very cloudy and unpleasant after one year in bottle. No. 66 had a very marked bitter flavour, usual for this variety, and threw down a very heavy deposit in bottle.

Single Variety Ciders and Perries.

In each case the pomace was pressed immediately after milling, and allowed to ferment naturally in cask, without keeving (unless otherwise stated), until the specific gravity had dropped to 1·025—1·035 in the average case, when the liquor was filtered.

No.	Name of Variety.	District where Grown	Date of Making	Specific Gravity of Fresh Juice.	Malic Acid per cent	Tannin per cent	Rate of Fermentation at 28° C	Special Treatment	Specific Gravity May, 1916.
	APPLES—Sharp Varieties.								
1	Porter's Perfection	South Petherton ..	Dec. 22nd	1·040	·33	·11	6·5	....	1·014
2	Bell	Copplestone	Nov. 12th	1·043	·67	·10	7·2	....	1·015
3	Ponsford	Copplestone	,,	1·043	·65	·10	6·6	....	1·018
4	Carrion	Hereford	Dec. 7th	1·043	·40	·20	4·0	....	1·020
5	Cap of Liberty ..	Martock	Nov. 8th	1 045	·71	·19	4·0	....	1·020
6	Lambrook Pippin ..	Martock	Dec. 22nd	1·045	·38	·15	5·0	....	1.017
7	Ramping Taurus ..	Malvern	Nov. 22nd	1·045	·24	·15	6·8	....	1·010
8	Red Foxwhelp ..	Hereford	Nov. 2nd	1·037	·67	·20	4 0	....	1·026
9	Moorman's Pippin ..	Newton Abbot ..	Nov. 23rd	1·046	·63	·22	3·8	....	1·023
10a	Ponsford	Chawleigh	Nov. 20th	1·049	·67	·12	4·7	....	1·024
10b	,, ...	,, ...	,,	1·049	·67	·12	4·7	Keeved	1·030
11	Red Streak	Ledbury	,,	1·045	·74	·10	2·5	....	1·027
12	Bickington Grey ..	Newton Abbot ..	Dec. 6th	1·041	·69	·15	4·8	....	1·029
13	Old Foxwhelp ..	Hereford	Nov. 4th	1·048	·58	·21	4·2	....	1·029
14	Cap of Liberty ..	South Petherton ..	Dec. 7th	1·045	·66	·21	2·3	....	1·030
15	Never Blight ..	North Cadbury ..	Nov. 22nd	1·046	·40	·13	4·0	....	1·027
16	Woodsell	Hereford	Nov. 10th	1·048	·61	·11	4·5	....	1·032
17	Red Streak	Leominster	Nov. 22nd	1·045	·83	·09	3·0	....	1·032
18	Butter Box	Newton Abbot ..	Nov. 20th	1·046	·64	·18	2·4	....	1·031
19	Red Soldier	Hereford	Nov. 22nd	1·058	·81	·31	2·7	....	1·035
20	Old Foxwhelp ..	Hereford	Dec. 7th	1·052	·70	·25	3·2	....	1·037

21	Kingston Black	.. Martock ..	.. Nov. 4th	1·050	·46	·15	10·2	....	1·018
22	,, ..	.. Ledbury ..	.. Nov. 12th	1·043	·35	·16	4·4	....	1·023
23	,, ..	.. Wells ..	.. Nov. 5th	1·052	·50	·21	4·6	....	1·031
24*a*	,, ..	.. Lambrook ..	.. Nov. 8th	1·052	·46	·13	6·4	....	1·029
24*b*	,, ..	.. ,, ..	.. ,,	1·041	·37	·10	5·1	Pressed without grinding.	1·028
25	,, ..	.. Martock ..	.. ,,	1·052	·45	·16	5·1	....	1·029
26	,, ..	.. Hereford ..	.. Dec. 6th	1·047	·42	·19	3·1	....	1·029
27*a*	,, ..	.. ,, ..	.. Nov. 5th	1·052	·47	·18	3·3	....	1·029
27*b*	,, ..	.. ,, ..	.. ,,	1·052	·47	·18	3·3	Juice heated to 50° C., and added yeast No. 27.	1·032
27*c*	,, ..	.. ,, ..	.. ,,	1·052	·47	·18	3·3	Kept at 15° C.	1·028
27*d*	,, ..	.. ,, ..	.. ,,	1·052	·47	·18	3·3	Added yeast No. 27 and kept at 15° C.	1·023
27*e*	,, ..	.. ,, ..	.. ,,	1·052	·47	·18	3·3	Juice heated to 50° C., added yeast No. 27 and kept at 15° C.	1·029
28	,, ..	.. Brockley ..	.. Dec. 2nd	1·050	·42	·16	4·8	....	1·031
29	,, ..	.. Taunton ..	.. Nov. 5th	1·046	·44	·14	4·7	....	1·030
30	,, ..	.. Bridgwater ..	.. ,,	1·051	·45	·17	4·7	....	1·031
31	,, ..	.. Ledbury ..	.. Nov. 12th	1·050	·51	·17	3·8	....	1·035
32*a*	,, ..	.. Hereford ..	.. Nov. 3rd	1·063	·68	·23	3·9	....	1·034
32*b*	,, ..	.. ,, ..	.. ,,	1·063	·68	·23	3·9	Keeved	1·033
32*c*	,, ..	.. ,, ..	.. ,,	1·063	·68	·23	3·9	Juice heated to 60° C., and added yeast No. 34	1·040
	SWEET VARIETIES.								
33	Maynard's Sweet	.. Martock ..	.. Nov. 4th	1·045	·19	·19	5·1	....	1·009
34	Spotted White	.. Alphington ..	.. ,,	1·056	·21	·14	7·6	....	1·017
35*a*	Eggleton Styre	.. Ledbury ..	.. Dec. 3rd	1·060	·28	·19	5·6	....	1·020
35*b*	,, ..	.. ,, ..	.. ,,	1·060	·28	·19	5·6	Juice heated to 45° C., and added yeast No. 7	1·021

Single Variety Ciders and Perries—*continued.*

No.	Name of Variety	District where Grown.	Date of Making	Specific Gravity of Fresh Juice	Malic Acid per cent	Tannin per cent.	Rate of Fermentation at 28° C	Special Treatment	Specific Gravity May, 1915
36	Sweet Alford	Newton St. Cyres	Nov. 4th	1·047	·18	·15	5·2	....	1·021
37a	,,	Chawleigh	Nov. 9th	1·048	·23	·19	5·6	....	1·022
37b	,,	,,	,,	1·048	·23	·19	5·6	Apples washed with formalin solution (·5%)	1·024
38	Hancock's Seedling	Milverton	Dec. 7th	1·054	32	17	4·3	...	1·024
39	Slack-ma-Girdle	Newton Abbot	Nov. 22nd	1·050	·19	14	4·5	..	1·026
40a	Sweet Alford	Alphington	Oct. 28th	1·048	·18	14	4·5	Kept at 15° C.	1·028
40b	,,	,,	,,	1·048	·18	·14	4·5	Kept at 15° C. added yeast No. 37	1·026
40c	,,	,,	,,	1·048	·18	·14	4·5	Juice heated to 50° C, added yeast No 37, and kept at 15° C.	1·029
40d	,,	,,	,,	1·048	·18	·14	4·5	....	1·028
40e	,,	,,	,,	1·048	·18	·14	4·5	Juice heated to 50° C., and added yeast No. 37	1·028
40f	,,	,,	,,	1·048	·18	14	4·5	Added 2 gallons of lees per 50 gallons	1·024
40g	,,	,,	,,	1·048	·18	14	4·5	Added 4 gallons of lees per 50 gallons	1·020
40h	,,	,,	,,	1·048	·18	·14	4·5	Juice saturated with CO2.	1·027
40i	,,	,,	,,	1·048	·18	·14	4·5	Juice added 5 grams sulphur dioxide per hectolitre (22 gals.)	1·028
40j	,,	,,	,,	1·048	18	14	4·5	Juice added 10 grams sulphur dioxide per hectolitre	1·027
41a	Ansell	Newent	Feb. 3rd	1·056	·40	·17	5·7	....	1·034

	Bittersweet Varieties.								
41	Passe Reine de Pomme	Brockley ..	.. Dec. 2nd	1·049	·24	·34	5·2	....	1·011
42	Black Norman ..	Ledbury ..	.. Nov. 3rd	1·047	·26	·24	7·7	....	1·015
43	White Close Pippin	North Cadbury	.. Nov. 22nd	1·056	·15	·32	5·2	....	1·019
44	Sandford Jersey ..	North Cadbury	.. Nov. 22nd	1·047	·20	·24	3·5	....	1·019
45	Cummy Norman ..	Weobley ,,	.. Nov. 3rd	1·053	·21	·24	5·8	....	1·020
46	Twistbody Jersey ..	Martock ..	.. Nov. 4th	1·051	·15	·30	4·2	....	1·018
47	Bryan's Bittersweet	Newent ..	.. Nov. 4th	1·051	·15	·25	7·3	....	1·016
48	Handsome Norman	Ledbury ..	.. Nov. 20th	1·057	·32	·39	5·5	....	1·024
49	Dove	Glastonbury	.. Nov. 22nd	1·050	·19	·27	5·1	....	1·026
50	Royal Wilding ..	Ledbury ..	.. Nov. 9th	1·045	·25	·20	4 8	....	1·026
51	Newton Jersey ..	Newton St. Cyres	.. Nov. 4th	1·048	·25	·30	4 5	....	1·027
52	Knotted Kernel ..	Weobley ..	.. Nov. 9th	1·045	·22	·33	5·0	....	1·028
53	Royal Wilding ..	Hereford ..	.. Nov. 9th	1·051	24	·26	5·7	....	1·024
54	Knotted Kernel ..	Hereford ..	.. Dec. 7th	1·048	·20	·30	3·5	....	1·031
55	Late Jersey ..	Martock ..	.. Dec. 9th	1·046	·40	·30	3 0	....	1·031
	Pears.								
56	Bosbury Scarlet ..	Ledbury ..	.. Nov. 3rd	1·053	·22	·23	6·8	....	1·020
57	Similar to Moorcroft	Newent ..	.. Oct. 13th	1·046	·41	·08	5·3	....	1·023
58	Barland	Malvern ..	.. Oct. 4th	1 050	·45	·09	6·6	....	1·024
59	Tom	Newent ..	.. Oct. 13th	1·056	·40	·12	5·4	....	1·024
60	Spice	Malvern ..	.. Oct. 22nd	1·040	·33	·13	6·8	....	1·022
61	Moorcroft	Hardwicke ..	.. Sept. 27th	1·057	·48	·14	4·2	....	1·028
62	Oldfield	Tibberton ..	.. Nov. 20th	1·050	·47	·14	4·4	....	1·028
63	,, ...	Malvern ..	.. Nov. 1st	1·047	·14	·14	5·5	....	1·030
64	,, ...	Ledbury ..	.. Nov. 3rd	1·052	·44	·10	4·3	....	1·030
65	,, ...	Stonehouse ..	.. Nov. 20th	1·056	·55	·23	3·6	....	1·034
66	Rock	Berrow ..	.. Nov. 20th	1·065	·37	·70	3·2	....	1·030

The Pasteurization of Bottled Ciders.

In continuation of the pasteurizing experiments mentioned in the last Report some of the ciders and perry bottled in the Spring of 1916, were pasteurized at different temperatures. The method used was the same as last year, the details being as follows :—After the bottles had been corked and wired, they were stacked upon their sides in a large metal vessel, which was filled with sufficient cold water to cover the bottles. The water was then slowly heated with steam, 30–40 minutes being taken to raise the temperature to the desired point. When the bottles had been kept as long as required at the pasteurizing temperature, they were taken out of the hot water and left to cool. The ciders were all filtered, carbonated, and bottled under a pressure of about 20lbs. The corks used were paraffin-waxed. It is especially important, when pasteurizing bottled ciders, to use good, large corks, otherwise too much loss of gas and sometimes of liquid takes place. The bottles must not be filled too full; it is necessary to leave a space of at least one inch between the bottom of the cork and the surface of the cider, so as to allow for expansion during pasteurization. By heating from ordinary temperature to 50°C. (122F.) the increase in volume is a little over 1 per cent; so in a champagne pint bottle containing 400c.c. there will be an increase of volume of about 4·5c.c. during the pasteurization. In addition to this increase of volume the extra pressure of the gas at the higher temperature has to be taken into account.

The following ciders were used :—

Kingston Black (bottled and pasteurized March 14, 1916, at a specific gravity of 1·024).

Result of examination, January, 1917 :—

(1) Control (not pasteurized): Good, sweeter than following, not quite clear, small deposit, specific gravity 1·023, acidity equivalent to ·44 per cent. malic acid.

(2) Pasteurized 1 hour at 45°C. (113°F.): Good, faint trace of cooked flavour, clear, very little deposit, specific gravity 1·024; acidity ·52 per cent.

(3) Pasteurized for 2 hours at 45°C.: as 2, but specific gravity 1·024; acidity ·50 per cent.

(4) Pasteurized for 1 hour at 50°C. (122°F.): good, trace of cooked flavour, clear, hardly any deposit, specific gravity 1·024; acidity ·50 per cent.

Blend No. 4 (a mixture of Cap of Liberty with several other ciders, bottled March 15th, 1916, with specific gravity of 1·027).

Result of examination, January, 1917 :—

(1) Control (not pasteurized): Flavour unpleasant, not quite clear, small deposit, specific gravity 1·021 ; acidity ·52 per cent.

(2) Pasteurized 1 hour at 45°C.: Flavour very good with a faint trace of cooking, clear, very small deposit, specific gravity 1·026 ; acidity ·66 per cent.

(3) Pasteurized 2 hours at 45°C. ; As 2, only cooked flavour easier to distinguish.

(4) Pasteurized 1 hour at 50°C.: As 3.

Old Foxwhelp (bottled March 28th, 1916, at a specific gravity of 1·028, and pasteurized).

Result of examination, January, 1917 :—

(1) Control (not pasteurized): Very good, clear, very small deposit, specific gravity 1·028; acidity ·64 per cent.

(2) Pasteurized 1 hour at 50°C.: As 1, but a very faint trace of cooked flavour can be detected.

Oldfield Perry (bottled March 28th, 1916, specific gravity, 1·029).

Result of examination :—

(1) Control (not pasteurized): Good, clear, very small deposit, specific gravity 1·028 ; acidity ·48 per cent.

(2) Pasteurized 1 hour at 50°C.: As 1, no trace of cooked flavour.

The pasteurized ciders had, in all cases where no leakage round the cork had taken place, kept a fair amount of gas, and were sufficiently sparkling for ordinary purposes. In the unpasteurized controls, where a little fermentation had taken place, there was, of course, more gas development; in the case of Blend No. 4 rather too much. At the same time this control sample had developed an unpleasant musty flavour, often found as a taint in old ciders. This flavour is probably due to the growth of a bacterium, which at the same time reduces the amount of acid in the cider. An attempt is being made to isolate this organism.

Of all the pasteurized ciders it can be said that the object of the treatment, viz., to keep them both sweet and free from disorders had been obtained, as they were all in good condition, quite clear, with hardly any deposit and with a good flavour. In all cases,

with the exception of the perry, there was a trace of the cooked flavour, but generally so slight that it would probably not be detected unless specially sought for.

THE INFLUENCE OF TEMPERATURE AND ACIDITY UPON THE CIDER SICKNESS BACILLUS.

In the Report for 1915 some experiments were mentioned regarding the action of temperature and acidity upon cultures of the sickness bacillus. Further experiments have been carried out dealing with this subject, and also some to find out if the concentration of sugar has any influence.

Tubes containing sterilised solutions of glucose in yeast water were inoculated from a young, vigorous culture of the sickness bacillus. The tubes were then placed in a water bath, which was heated to the temperature wanted in 30 minutes, and taken out, cooled and placed in the incubator after being exposed to the test temperature during varying periods of time. They were subsequently kept under observation in the incubator for three weeks.

In the following tables + indicates that the bacillus developed after being exposed to the temperatures mentioned, — shows that no development took place.

Tubes with different concentrations of glucose in yeast-water :—

At 45°C. : Solutions containing 3, 4, 5, 6, 7, 8, 9 and 10 per cent. of glucose were exposed to 45°C. for 5, 10, 15, 20, 30, 45 and 60 minutes. All cultures developed after this treatment.

At 50°C. : Result exactly the same as at 45°C.

At 55°C. :

	5 Min.	10 Min.	15 Min.	20 Min.	30 Min.	45 Min.	60 Min.
3% Glucose ...	+	+	+	+	—	—	—
4% " ...	+	+	+	+	—	—	—
5% " ...	+	+	+	+	+	—	—
6% " ...	+	+	+	+	—	—	—
7% " ...	+	+	+	+	—	—	—
8% " ...	+	+	+	+	—	—	—
9% " ...	+	+	+	+	+	—	—
10% " ...	+	+	+	+	—	—	—

In another set of experiments at 55°C. no development took place, even in the tubes kept for five minutes. It seems that 55°C. is very near the critical temperature for the sickness-bacillus, as it is killed in some cases and in others not. The percentage of glucose does not seem to have any influence upon the organism as far as its resistance to temperature is concerned.

Tubes with various percentages of acid :—

Sterilised solutions of 5 per cent. of glucose in yeast water and various quantities of malic acid were treated in a similar manner with the following results :—

At 40°C. :—

	5 Min.	10 Min.	15 Min.	20 Min.
·1% Malic acid	+	+	+	+
·25% „ ...	+	+	+	+
·50% „ ...	+	+	+	—
·75% „ ...	—	—	—	—
1·00% „ ...	—	—	—	—

At 45°C. :—

	5 Min.	10 Min.	15 Min.	20 Min.
·1% Malic acid	+	+	+	+
·25% „ ...	+	+	+	—
·50% „ ...	—	—	—	—
·75% „ ...	—	—	—	—
1·00% „ ...	—	—	—	—

At 50°C. :—

	5 Min.	10 Min.	15 Min.	20 Min.
·1% Malic acid	+	+	+	+
·25% „ ...	—	—	—	—
·50% „ ...	—	—	—	—
·75% „ ...	—	—	—	—
1·00% „ ...	—	—	—	—

It will be seen that malic acid greatly diminishes the resistance to higher temperatures. At 50°C. ·25% of acid is sufficient to prevent development even after exposure for five minutes only. At 45°C. a percentage of ·5 prevents development, whereas at 40°C. with one exception only the cultures containing ·75 per cent. or more of acid did not develope.

Trials with a Hydraulic Press for Cider-Making.

During the last cider-making season the new hydraulic press which has been erected in the cider house at the Station was used for pressing the pomace and gave entire satisfaction. The following information concerning its working is therefore included here, since it may prove of service to practical cider-makers. It is much easier to work and presses at a quicker rate than the old screw-press hitherto used at the Station. Also the yield of juice is superior. At the trial pressing the yield was 81·44lbs. of juice per 100lbs. of mixed apples, which corresponds to 8·71 gallons per cwt., or 175·24 gallons per ton of fruit. The average yield during the whole season was 167·3 gallons of juice per ton of apples, the lowest being 153·4 gallons and the highest 175·4 gallons per ton. The average figures

NEW EXPERIMENTAL ORCHARDS PLANTED IN 1916–17.

Centre.	Varieties Selected.			
	Apples.			Pears.
	Sharp.	Sweet.	Bittersweet.	
Gloucester County Trees.				
Arlingham (50)	Kingston Black (10) Foxwhelp (10) Gatcombe (10) Page's Yellow (5)	Sweet Woodbine (5)	Fréquin Audièvre (5) Harry Masters' Jersey (5)	
Standish (55)	Cowarne Red (6) Kingston Black (7) Skyrme's Kernel (6) Dufflin (2) Cap of Liberty (6)	Sweet Coppin (3) Eggleton Styre (6) Sweet Alford (3)	Royal Wilding (6) Cherry Norman (4) Strawberry Norman (6)	
Dymock (50)				Amphett (10) Holmer (10) Huffcap (10) Lintot (5) Pine (5) Port (5) Hellens Green (5)
Brockweir (18)	Gatcombe (3) Cap of Liberty (3)	White Alphington (3)	Fillbarrel (3) Fréquin Audièvre (3) White Close Pippin (3)	
Stonehouse (36)	Page's Yellow (12)	Sweet Alford (12)	Harry Masters' Jersey (12)	

Hereford County Trees.				
Pixley Court, Ledbury (150)	Dymock Red (10) Lambrook Pippin (10) Langworthy (10) Yeovil Sour (10)	Eggleton Styre (10) Sweet Coppin (10) Sweet Woodbine (10)	Bédan des Partes (10) Strawberry Norman (10) Cherry Norman (10) White Bache (10) Knotted Kernel (10) Yarlington Mill (10) Royal Wilding (10)	
Worcester County Trees.				
Welland, Malvern (50)	Cap of Liberty (10) Kingston Black (10)	Butleigh No. 21 (10) Sweet Alford (10)	Médaille d'Or (10)	
Stoke Heath (18) ..	Eastham Cider (3) Dymock Red (3) Kingston Black (3)	Sweet Alford (3)		Barland (3) Claret (3) Moorcroft (3)

for the season before, when working with the screw press were 72·8lbs. of juice per 100lbs. of apples and 155·4 gallons per ton. The increase in yield due to the hydraulic press was thus about 12 gallons per ton of apples if no allowance is made for seasonal variations in yield.

The working of the press is very simple. From a container water is pumped by means of a small, strong pump into the press cylinder and forces up the ram, which on its head carries the press bed, towards the top of the press, being kept in position by four strong iron standards. On the press bed is placed a bogie on wheels carrying the cheese. As the ram is forced upwards the pressure increases slowly until it reaches 60 tons (about 1,013lbs. pressure per square inch of the ram); then a safety valve opens and allows the surplus water to flow back into the container. The cheese is generally kept for 15–20 minutes at the highest pressure. Each cheese consists of 8–10 cloths of pomace, containing about a cwt. each.

New Trial Cider and Perry Orchards, 1916–17.

The development of the scheme for establishing a series of trial cider and perry orchards throughout the West of England, which was planned when the Institute first started work, has naturally been greatly affected by the war. The scarcity of labour and the high cost of fencing trees have made it impossible to proceed with the planting of new orchards in several instances, and for the same reasons some of the already established centres which were originally only partially planted are still incomplete. Notwithstanding these difficulties a few new centres have been started this season, 407 trees having been distributed for this purpose. Particulars relating to these new centres are given in the accompanying table.

It is unfortunate that at such a time there is a considerable stock of trees, propagated before the start of the war for distribution under this scheme, which have now reached the stage when it is necessary that they should be planted in their permanent quarters. After next season's supply, which will be limited, several years must elapse before another batch can be available for the purpose; and it is also doubtful when it will be possible to start fresh nursery work on any considerable scale.

In order to avoid waste of trees the surplus were offered on the usual terms to members and associates of the Institute, and over 750 were disposed of in this way. More than 250 have also been distributed through the Devon Agricultural Education Committee for the purpose of re-stocking old orchards in that county.

In all 1,456 trees have already been sent out during the 1916–17 planting season.

INVESTIGATIONS ON DISEASES OF PLANTS AND THEIR TREATMENT.

A Black Rot of Apples.

The black rot of apples described in the Report for 1915 has been the subject of further investigations during the last year. In July, 1916, ten varieties of apples were inoculated with *Mònilia fructigena.* The apples were quite small and immature, being only about one inch in diameter. In seven days' time all the apples developed the typical brown rot, and in no case was any sign of blackening found, which was quite contrary to expectation, as many of these varieties had developed the black rot in the previous winter. In August more inoculations were made, and this time blackening appeared in a number of cases : it was, however, noticeable that some varieties such as Médaille d'Or and Strawberry Norman, which last year showed the most extreme type of black rot, were only partially blackened and bore very many spore-pustules on their surface. Further inoculations in September and at the end of October produced black, brown and intermediate types of rot, different varieties of apples showing almost or exactly the same kind of rot as they did last year. Some fresh varieties were also used in these tests.

The following list shows the type of rot produced by *Monilia fructigena* in mature apples of different varieties :—

Médaille d'Or Yeovil Sour Harry Masters White Jersey Sweet Alford Strawberry Norman	Typical black rot.
Kingston Black Knotted Kernel Cap of Liberty Dabinett Cowarne Red Fréquin Audièvre	Quite or mainly black : sometimes numerous fructifications.
Dove Doux Amer Eggleton Styre Rouge Bruyère Bramley's Seedling Gascoigne's Scarlet Seedling Royal Jubilee	Some blackening : numerous fructifications.
Reinette Obry Cremière Court Pendu Plât Allington Pippin King's Acre Pippin American Mother Oregon Newtown Lord Suffield	Typical brown rot.

The above classification shows the type of rot to be expected as a rule on apples of the different varieties, but on apples of a certain kind the rot produced varies to some extent. Thus a Kingston Black or a Knotted Kernel might sometimes be put in the first class and at other times towards the bottom of the second class. The two intermediate classes shade into the extreme classes and into one another; but on the whole it may be said that apples in the first two classes tend to develop more or less typical black rot, while those in the last two classes usually show more or less typical brown rot. The most variable apple tried was Sweet Alford, which sometimes showed scarcely any tendency to black rot, though in most cases the typical black rot appeared.

The kind of rot produced by *Monilia fructigena* cannot yet be correlated with any chemical or physical character of the apple. but as the brown rot appears on all very young apples when inoculated it is evident that the factor which causes black rot is only developed when the apple approaches maturity.

Examination under the microscope of thin sections of brown-rotted apples shows that the whole flesh of the apple is filled with fungus mycelium, which grows chiefly between the cells, but also occurs sometimes inside the cells. Most of the flesh of a black-rotted apple seems to contain less mycelium, but a large amount of mycelium is concentrated just underneath the skin. The tissues to a depth of about six cells below the epidermis are filled with a mass of hyphæ. Intercellular spaces and the middle lamella of cell-walls are tightly packed with mycelium, though hyphæ are not often found inside the cells: no mycelium is found in the thick cuticle. In short, the fungus forms a sclerotium which is very thin but which extends all over the apple, forming a kind of shell below the epidermis. It is this sclerotium which forms the leathery or rubber-like skin of the black apples. In thin sections the mycelium appears yellowish or very light brown, while the same colour often occurs in the cell-walls of the apple which are included in the sclerotium. Apparently the black colour of the apple is due to the coloured hyphæ as seen in the mass. Apples attacked by *Monilia fructigena* develop the black type of rot when the fungus forms a sclerotium below the epidermis instead of growing more generally throughout the flesh and piercing the cuticle to form pustules of spores on the outside of the apple. Possibly the sclerotium is formed because the fungus is unable to make its way through the cuticle, or because the middle lamella of the host-cells is in a condition which favours the growth of the fungus there; but in any case it is found that the particular conditions which bring about the

formation of a sclerotium are only present in fairly mature apples of certain varieties.

Apples were also inoculated with *Monilia cinerea*, obtained from plums, in August, September and October. Here the results were rather irregular and it is impossible to classify the varieties of apples according to the kind of rot produced in these tests. On the whole there seemed to be less tendency to the production of black rot as the season advanced. Apples often produced very many small external bunches of hyphæ without many spores, and on the other hand there was often very little external development of the fungus, which grew internally without producing the expected blackening. More inoculation experiments with *Monilia cinerea* are necessary before any definite statement as to its effect on different apples can be made.

A Spot Disease of Apples.

The Annual Report for 1914 contained an account of a spot disease of apples which was very prevalent during the winters of 1913 and 1914. This disease has again been prominent on some varieties of apples during the winters of 1915 and 1916, and a little more information about it has been gained.

As previously mentioned, the spots always appear around the lenticel-like structures which occur in the skin of the apple, the first sign of disease being a slight discolouration of the "lenticel." The discoloured area is extremely small and inconspicuous, and can only be seen when the apple is very carefully examined with a lens. Spots have only been noticed in rare cases on freshly gathered apples, but it is quite possible that the first stage of the spot may have been present in other instances, so inconspicuous as to be overlooked. After storage for some time in the fruit room the spots become noticeable to the naked eye, but are still quite small and not larger than a pin's head: they may remain in this stage for a considerable time without increasing in size to any extent. Finally the spots begin to grow more rapidly, and, in the worst cases, a large part of the surface of the apple may be covered by spots which have grown until they meet each other. In the earlier stages the spots all look alike, but later they may show differences in the rate of growth, colour and softness or firmness of the spot.

More cultures of fungi have been made from the spots, and each spot usually yields a pure culture; but a number of different fungi have been found, and some of them are different from those obtained from the apple spots in previous years. Spots which appear similar may or may not yield the same fungus, but spots of different types

are always found to contain different fungi. Various infection experiments with these fungi have been made to try to produce the spots on apples, and control apples have been kept under careful observation to see whether they also developed spots. The following tests were made with apples of the varieties Bramley's Seedling, Newton Wonder, American Mother and Allington Pippin in November and December, when the spots were appearing naturally on stored apples.

"Lenticels" which were apparently quite healthy were marked and examined at intervals: after a month they were all still healthy and showed no sign of discolouration, spot or fungus. "Lenticels" which showed the very first signs of fungus attack, that is, a slight discolouration but no spot which could be detected by the naked eye, were marked and examined at intervals. A fortnight later some of the discoloured areas had increased in size, while a month later some distinct spots had formed. At this time about 50 per cent. of the marked "lenticels" had produced spots of the usual type, while another 25 per cent. were apparently beginning to form spots.

Mycelium from several cultures was applied to the surface of "lenticels" and the apples were placed in a fairly moist atmosphere in the laboratory at room temperature. In the first series of these trials it was not noticed whether the "lenticels" were quite healthy or not, and in a second series it was known that they were discoloured. Distinct spots formed in a few cases and rot appeared to be just starting in many of the others, but in the circumstances it is not possible to say whether this was due to the inoculations or to the previous presence of a fungus. Surface inoculations on healthy "lenticels" usually produced no spots after a month, though in some cases a very slight infection seemed to have taken place. Other healthy "lenticels" were injured by burning with a red-hot needle, some of them being afterwards inoculated on the surface with fungus mycelium while others were left as controls. None of the controls showed any sign of fungus attack after a month, but almost all the inoculations resulted in some infection, in some cases distinct spots being produced in a month. Inoculations were also made by punctures in healthy "lenticels" and the majority of them caused typical spots to appear in a month, while others only produced a slight infection at that time. Punctures made with sterile needles produced no infection. Seven different cultures of fungi obtained from apple spots were used for these various inoculation tests and they all caused the formation of spots, though some appeared to do so more readily than others.

The information concerning these apple spots at present acquired may be summarised as follows:—The spots may be caused by various fungi. The fungus enters the apple through a "lenticel" some time before the first sign of a spot appears, but the actual time of entry is not known: it may be after the apple is gathered or before, or even when the "lenticel" is first formed. The fungus for a time makes very little growth and only produces a noticeable spot when the apple has reached a suitable state of ripeness: the spot then grows rapidly. In November and December apples, as a rule, can only be infected through injuries and not through uninjured "lenticels."

A Root-rot of Black Currants.

In the autumn of 1915 several dead bushes were found in a four-year-old plantation of black currants at the Research Station. No sign of insect or fungus attack could be found on the shoots, but on examining the roots it was found that they were all dead, dark-coloured and decaying, and there was an abundance of fungus mycelium in white felted sheets in the bark and between the bark and wood.

In the early summer of 1916 other bushes in the same plantation were found to be dying: their leaves failed to grow to their normal size, and after a time a part or the whole of each diseased bush died off. The shoots and leaves were free from any parasitic growth and their death appeared to be due to a stoppage of the flow of water and food-materials from the roots. The roots were again found to be full of mycelium which also extended upwards in the main stem an inch or two above the ground-level. In bushes which showed only the first signs of attack the fungus appeared only in some of the roots, the remainder being healthy: the dead roots all occurred on the same side of a bush. Often the majority of the roots of a bush were killed before the shoots began visibly to fail. The fungus appeared to enter the plant near the crown or at the point where the main roots divide, or perhaps at the base of the original cutting, and then to spread downwards to the smaller roots.

Pure cultures of the fungus were made and grown on sterile wood blocks: growth readily occurred on black-currant, apple and plum wood, the surface of the blocks being more or less covered with a thin layer of white or light brown mycelium. But the chief growth takes place between the bark and the wood, and from this part at the edge of the block small tongue-like bodies often

grow out into the air: they are, however, merely firm masses of sterile mycelium, not fructifications, and as the culture ages they dry up. When grown on malt-extract-gelatine in tubes the fungus forms a thick covering on the surface of the gelatine and then grows down into the medium in a very characteristic manner, producing bodies resembling coarse branching roots or stag's horns.

Attempts have been made to inoculate young black- and red-currant cuttings growing in pots. Mycelium from cultures has been placed in cuts and beneath the bark of the cutting both below and just above the level of the soil: portions of the wood-block cultures have also been placed among the roots of the cuttings. At the time of writing these inoculations have mainly given negative results, only one cutting having become slightly infected by the fungus.

The plantation in which the diseased bushes occur is on the site of an old cider orchard, which was cleared just before the black-currants were planted, and from time to time old decayed tree-roots are dug up on the plantation. These are very often filled with mycelium which is apparently identical with that occurring on the roots of the black-currants, and it is thought that these old roots in the soil are the source from which the black-currants are infected. Support is given to this theory by the case of a young apple plantation planted on the site of an old orchard near Cleeve. Many of the young trees are doing badly, and in some cases are even dying: some of the worst were dug up, and it was found that the roots were infected with a fungus which appears, both in its natural growth and in artificial cultures, to be identical with that on the black-currant.

It therefore appears that fruit-trees, at all events apples and black-currants, when planted on the site of an old orchard are very liable to be attacked by a root-fungus present in the old roots which are left in the ground. As no fructifications of the fungus have yet been found either on its natural hosts or in cultures it is impossible to identify it, though it is suspected to be something of the *Armillaria* type. Details of the time and method of infection have also still to be investigated.

"Reversion" of Black Currants.

This disease has, during the last few years, been the cause of extensive loss to the growers of black currants. It is known under several names beside "Reversion," such as "Going Wild," "Wildness," "Nettle Leaf," and possibly "Running Off." It is very elusive in nature and often indefinite in character. Fre-

quently part only of a bush will have reverted while the rest is still normal. Its chief characteristics are as follows :—

(1) Sharp pointed, abnormally narrow leaf, with a more than usually serrate margin.

(2) Abnormally long internodes.

(3) Extensive growth of the laterals resulting in a crowded instead of an open form of bush.

(4) " Running Off " of the fruit, *i.e.*, failure to set properly. Often the only fruits set are two or three berries at the base of the truss.

In a reverted bush some or all of these characteristics may be present.

As stated above, the disease often appears quite gradually, and until the eye is trained it is difficult to tell for certain whether a given bush is reverting or not.

The names " Reversion " and " Going Wild " implied that the disease was due to a reversion to the wild type of black currant.

No explanation, however, was ever forthcoming as to why this took place or why, if it did, the bush should fail to bear.

The first observation that cast any illumination on the problem was that of Mr. E. A. Bunyard, who called attention to the fact that in all cases noticed by him reversion was accompanied by injury to the terminal bud and consequent growth of the laterals.

The disease has been under investigation at Long Ashton since 1914, though it is only during the last year that sufficient material has been obtained to start experiments on any scale. In 1915, before Mr. Bunyard's theory had been noticed, it was felt that there was some connection between injury to the terminal bud and the disease. To test this idea the terminal buds were cut off several bushes during the summer time. This treatment resulted, as was natural, in two to four laterals, situated immediately below the terminal, starting into growth. This, though at first sight appearing to resemble the truly reverted state, was seen on closer investigation to be distinctly different. One striking characteristic of the laterals on a reverted bush is the very low point from which some of them originate, whereas all the laterals arising from the decapitated shoot came from just below the point of cutting. From this, therefore, one may assume that killing the terminal bud is not sufficient to account for development of laterals as found in a reverted bush. It had been noticed in visits to black currant plantations in Worcestershire and Herefordshire that Reversion

and Big Bud were often present in the same group of bushes, and this naturally gave rise to the suspicion that the two might be connected in some manner. Yet again other plantations might be found in which many bushes were reverted, but only the merest trace of Bud Mite could be found. This, at first sight was confusing, unless Reversion could be produced by other causes beside Big Bud.

It was not until sufficient reverting bushes were obtained at Long Ashton that it was possible to obtain any insight into the causes operating.

Methods Adopted.—In June the bushes under observation were examined and those that showed any sign of reversion were divided into three classes. The first were labelled "suspicious," and included all those that tended to have the narrow pointed type of leaf, but showed none of the signs belonging to the other two classes. The second, labelled "going," included those which, beside showing the pointed leaf, were obviously more densely filled with laterals than a normal bush, while the third class, labelled "gone," show in addition to the characters of class two, a well marked running off of the fruit.

In winter these bushes were examined again, and it was then found that classes 2 and 3 were generally attacked by Bud Mite to a much greater degree than normal or class one bushes. The evidence, therefore, pointed strongly to Bud Mite being one cause of reversion.

Causes of Reversion.—Exactly how this happens may be surmised from an examination of a shoot becoming attacked by Bud Mite in the middle of June. If such a shoot be examined then, the typical distribution of the Mite in the buds is as follows. The terminal bud is attacked; then follow three or four wood buds free from it; then, still lower down on the shoot, two or three free buds which next year become flower buds. Still lower are several buds all containing mites, and at the extreme base one or two very small adventitious buds which are free. This distribution is the typical one, but there will, of course, be variations in the distribution.

The facts may be explained as follows. The shoot must have arisen at the start from a mite-free bud, since mited buds do not grow. Therefore up to the time when mite migration begins all the buds of the new shoot will be free. Suppose by the end of June the shoot under consideration shall have made 20 buds, including the terminal. During the time of active migration, that is up to the end of May or so, it will perhaps have made 10 buds in all, including the terminal. The chances are, therefore, that all these buds will be infected. The remaining ten buds will be made after

the active migration of mites has ceased so that the chances are that they will remain free. At the same time it must be remembered that the terminal bud was early attacked and that therefore the mites in that bud will be carried up with it, always provided that infestation is not so heavy as to stop growth.

The result at the end of June will be that the terminal bud will be attacked, then will follow 10 buds lower down free from mite, and the nine buds still lower that contain mite. Of the 10 immediately below the terminal the lowest six, perhaps, being older will be changed into rudimentary fruit buds towards the end of the summer, while the other four will remain in the condition of wood buds. It should be remembered that during most of the time that growth is taking place in the shoot under consideration the terminal bud is mite-infested and is, therefore, being severely checked in its activities. At the same time the sap ascending from the roots is normal in quantity and consequently more sap, presumably, enters the shoot than the terminal bud is capable of using. There is therefore a certain tendency on the part of the lateral buds to start into growth, a tendency that is at any rate greater than normal. Now the lowest nine buds are mite infested, and therefore cannot grow out, while the six buds immediately above are already tending to become flower buds so that these, too, generally remain stationary or nearly so. The four buds immediately below the terminal, however, are usually forced into unnatural growth in the current year.

There is one other point to be noticed and that is the condition of the adventitious bud or buds at the extreme base of the shoot. These are situated below the 20 buds that have been so far considered, and under normal conditions remain dormant. When the terminal bud is checked by the mite these buds tend to enlarge, but being formed after active mite migration usually remain free. At the end of the current year therefore, in this typical shoot, one finds a big bud at the tip, then lower down perhaps four laterals that have made a short growth, then six buds free from mite but already transformed into flower buds, then nine big buds, and at the extreme base one or two abnormally plump, mite-free, adventitious buds. The following year no growth can come from the terminal big bud but the four laterals below it grow out strongly. The six flower buds below make a short stubby growth or none at all, and the nine big buds below these, of course, remain without growth. The plump adventitious buds at the base grow into strong laterals.

This constitutes the first stage of reversion caused by Bud Mite.

The shoot is not yet reverted but bears fruit as a rule normally. It will be observed, however, that the second year's growth instead of being nearly all from the terminal bud as in a normal mite-free shoot, now consists of five or six branches. Now suppose that the same process goes on during the second year, and that, not on one shoot only, but on most of the shoots of the bush. By the third year the bush is a mass of weak laterals, and shows the condition that is typical of a reverted specimen. It may easily be supposed, though of this there is at present no proof, that the flowers borne on these weak laterals are too weak to bear fruit. Indeed, there is a certain amount of evidence to show that if the season is wet they are capable of bearing a fair amount, but if dry, although they appear to set normally, they soon drop off.

The above explanation serves as a working hypothesis in the case of bushes attacked by Bud Mite. There is, however, little doubt that Reversion may occur in the absence of Bud Mite and that therefore in these cases other causes must be sought.

It was found that among the bushes at Long Ashton marked as "going" many showed clear signs of having been attacked by aphis during the preceding year or two. As a result the five or six buds at the apex of the shoots had been killed and growth had taken place from several of the buds immediately below instead of being confined to the terminal bud. Here also there was a distinct tendency for the adventitious buds at the base of the shoot to grow out instead of remaining dormant. The tendency towards undue lateral growth is not so strong as in the case of Bud Mite attack, but it is quite distinct and if the same cause operated two years running, or even in alternate years, there would, in the absence of corrective pruning, be a distinct tendency to reversion.

Remedies.—The possible remedies for Reversion will, of course, depend on determining the true causes of the disease. It should be possible in cases of aphis caused cases to counteract the condition by carefully doing away with unnecessary laterals at pruning time. When caused by Bud Mite, pruning away the laterals will only act as a palliative and no certain cure can be obtained until a remedy for Big Bud be found or a truly mite-resisting variety raised.

Further Experiments on Big Bud Mite.

Of the formulæ used for spraying during the winter of 1915–16, as mentioned in the Report for 1915, the most successful has proved to be that containing 10 per cent. soft soap and 5 per cent. crude carbolic acid. The bushes show a considerable reduction in the

number of big buds as the result of the treatment, but the method as it stands is not yet suitable for commercial purposes. The spraying was done in December and was not repeated, in the hope that one treatment would prove sufficient. It was found, however, that though good penetration could be generally secured for the older buds at the base of the shoots the terminals and sub-terminals were often unaffected by the spray. There seems little doubt that these buds containing living mites sufficed to cause the moderate attack that took place during the summer of 1916. It is possible, however, that by giving two sprayings instead of one greater success would be obtained, and experiments have been started to test the point. The times selected for spraying are (*a*) the beginnning of December; (*b*) the beginning of January; (*c*) the end of February or as late as is safe before the normal buds begin to open.

The trial has been arranged so as to compare the results obtained by spraying at the times (*a*) and (*b*), (*a*) and (*c*), and (*b*) and (*c*). In addition to the varieties Ogden Black and Boskoop Giant previously under trial, others, namely "French," Lee's Prolific, Black Naples, Victoria and Baldwin have been brought into the experiment.

Miscellaneous Notes on Plant Pests and Their Treatment.

How late is it safe to lime spray?—There has always been some doubt as to how late it was safe to use a lime spray on fruit trees and various views have been held.

That it is desirable to spray late there is little doubt. As regards apples, the chief insects which may be controlled by lime spraying are the Apple Sucker and the Rosy Aphis. There are other aphids that attack the apple, but the Rosy Aphis is much the most injurious. This species causes bad leaf curling and a far greater stunting of the shoot than the two green kinds. Control measures should, therefore, be chiefly directed against the Rosy Aphis. In considering the best time to spray there are three points to remember. They are (1) the time the insect pest hatches; (2) the sticking power of the lime wash; and (3) the effect of the spray on the host plant.

(1) Apple Sucker begins to hatch in an average year at the beginning of April, and hatching goes on for a period of three weeks or so. The Rosy Apple Aphis does not hatch till the middle of April, and continues hatching for two or three weeks. Therefore the best time to spray in order to control both insects would be about the beginning of the second week of April.

(2) The sticking power of lime wash is unfortunately limited, and therefore it is best to apply it as late as possible consistently with fulfilling conditions (1) and (3). Directions were given in the Report for 1915 for getting the best and most lasting coat.

(3) The effect on the host plant is the most doubtful point, and accordingly some experiments were done in 1915 to obtain information.

Spraying was begun on March 17th, and continued, as the weather permitted, up to April 28th. Photographs were taken of twigs from selected trees so to show the exact stage at which spraying took place.

The stages varied from the condition in which the flower-truss bud was just beginning to open to the condition when the flowers themselves were nearly fully open.

Very little damage resulted, even in the later stages. The most marked injury occurred at the time of, and shortly after, a frost of 11° at the end of March. Otherwise only isolated varieties, such as Cox, Houblon, Lord Derby, Gascoigne's Scarlet Seedling, showed any signs. In no case, however, did the injury amount to more than a browning of the outer scale leaves, and the essential organs of the flower did not suffer. These experiments would, therefore, tend to suggest that the date arrived at under headings (1) and (2), namely, about April 8th, is the most suitable time.

These results are, however, drawn from only one year's experience, and it is easily possible that in seasons of frequent spring frosts more damage might be done.

Crops susceptible to Wireworm Damage.—Now that it is probable that much grass land will be broken up for cultivation the susceptibility of different crops to wireworm damage assumes a greater importance.

It is not possible in the present state of knowledge to say what soils will be the most likely to be badly infested with this insect, but there is a high probability in the case of any piece of grass land that future crops will suffer to a greater or less extent. While no crop, with the possible exception of mustard, is immune, yet there is no doubt that different crops vary in their susceptibility. Some information has been obtained from some grass land at Long Ashton broken up within the last two years and subsequently cropped with vegetables. For convenience crops may be divided into groups showing approximately equal susceptibility :—

GROUP (1). Very susceptible. Plants attacked at the fleshy collar and completely killed, dwarfed, or caused to go to seed prematurely :—

Onions.
Leeks.
Celery.
Lettuce.

GROUP (2). Rather susceptible. Growth dwarfed but plant not usually killed.

Runner Beans.
Dwarf Beans.
Peas.

Peas are placed in this group though the effects of wireworm are not usually so marked as in the case of Runner Beans.

GROUP (3).—Slightly susceptible.

The Cabbage Tribe.
Tomatoes.

By the time that plants of the cabbage family are ready to plant out the collar of the plant is fairly hard and usually escapes serious injury.

GROUP (4).—Injured by wireworm but not so as to endanger the life of the plant.

Potatoes.

The injury done to the potato is confined to the tuber as a rule, and the collar of the plant escapes. The new tubers are, however, seriously lowered in market value.

Carrots were not grown in the above trials, but would probably come in group (1).

In all cases where susceptible crops are grown more seed should (where possible) be used than would suffice for a normal sowing.

EXPERIMENTS ON THE TREATMENT OF RHIZOCTONIA DISEASE OF ASPARAGUS.

In 1915 specimens of diseased asparagus plants were sent for examination to Long Ashton by Mr. Gaut, the Agricultural Organiser for Worcestershire, the plants being taken from an asparagus plantation at Badsey. They were found to be badly attacked and

eventually killed outright by a soil fungus, *Rhizoctonia violacea, var. asparagi* (*R. medicaginis De C.*), which is the cause of a serious rot of the roots and crowns.

It was resolved to arrange a series of experiments in 1916 with the object of finding a method of eradicating the fungus from soil in which attacks had been localised. These were ultimately carried out on the affected land at Badsey, which was placed by the tenant at our disposal for the purpose. They have been conducted by members of the staff at Long Ashton acting in conjunction with Mr. Gaut, who very kindly undertook all local arrangements necessary and personally carried out most of the work actually entailed on the spot.

The land used for the experiment, which had been badly attacked in 1916, was divided into a series of seven plots, each of which received different treatment. One plot received no special treatment. The soil of the remaining six was treated respectively with bleaching powder, carbolic acid, creosote, lime, naphthaline, and sulphate of iron. The quantities of these substances applied per square yard were as follows:—Bleaching powder, 2ozs.; carbolic acid, 2ozs.; creosote, 1oz.; lime, 30ozs.; naphthaline, 2ozs.; sulphate of iron, ¾oz. In the first five instances the substance was applied in the early spring before the test crop was sown. The sulphate of iron was applied in two separate dressings at intervals during the summer. The test crop grown was carrots, this being selected as more suitable for the immediate purpose in hand than asparagus, and equally susceptible to attack. During the course of the growing season it became evident that differences in the results of the various forms of treatment were being obtained, the control plot presenting many gaps and diseased plants in the rows and the treated plots showing them to a less and variable degree according to the form of treatment applied. The differences in the colour of the foliage on the individual plots were noteworthy, and a striking feature on the creosote-treated plot was the relative immunity from weeds throughout the season.

The carrots were eventually lifted at the end of November and an estimate of the amount of disease on each plot was made. There was a marked contrast in the results on the treated and control plots, the latter showing very much more disease than any of the former, thus indicating that each form of treatment tested had some beneficial effect. So far as the individual treatments were concerned, undoubtedly the plots most free from disease were those treated with bleaching powder and creosote respectively. The sulphate of iron and lime plots came next in order of effect, carbolic acid and

naphthaline giving the least marked results. The effect of the treatment, particularly in the two first cases, is encouraging enough to admit of hope that repeated treatment on similar lines for two or three seasons might result in the practical eradication of the pest, and arrangements for further trials next season have therefore been made.

Apple Leaf Scorch.

Many cases of serious scorching of the foliage of apple trees and bushes have been reported during the past few seasons, and in the majority of instances the cause of the trouble has not been discovered. The types of scorching due to mechanical irritiation produced by the rubbing of leaves kept in movement by wind. dealt with in the Annual Report for 1913, and to the effect of various spray fluids, are not under consideration here, these being more or less distinct in character. The kind of scorching referred to generally starts at the margins or tips of the leaves, and spreads towards the centre of the leaves, until the greater or whole of the surface is affected. In typical cases where the trouble is well-developed the majority of the leaves on an affected tree show the scorching in a pronounced form, and at a distance the tree appears as if a wave of fire had passed over it. Frequently a whole plantation is attacked in this way. Sometimes the attack is localised to a single area in the plantation: and in mild outbreaks only a single or very few trees may be affected. In the latter cases growers have reported that the disease shows a tendency to spread in succeeding seasons, radiating out in various directions from the original centre of attack. Usually the foliage begins to show the first signs of scorching about the time when the first leaves of the season's growth are becoming fully expanded. The attack then increases in intensity until, perhaps by the middle to end of June or the beginning of July, the older leaves are almost completely scorched and wholesale defoliation occurs. Curiously, the leaves of the second growth of the season which begin to develop about this period generally remain free from any sign of scorching, and a month later the tree, which at the end of June, say, was as brown as if it had been partially burnt, may have completely regained its proper green colour. The time of attack varies somewhat from year to year, sometimes being deferred to the second half of the growing season: but June is the month when the trouble is most often noticed.

The fact, which has been repeatedly emphasized by growers, that the disease first makes its appearance at one spot in a plantation and then in after years spreads from that point suggests that the trouble is infectious and, therefore, caused by a living organism.

Repeated examinations of the leaves at all stages of scorching have been made, but no organism to which the disease could be attributed has been observed on them or within their tissues. The general way in which the foliage of an affected tree is attacked points to the probability of the source of the trouble being found at the root-system, since at the collar of the tree and on its main branch system there is no sign of anything abnormal. The roots of affected trees, however, seem quite normal in appearance, and the presence of any soil form of insect or fungus pest has neither been detected nor in any way indicated by an examination of the roots. The extent of the damage in all well developed cases is so pronounced that it seems inconceivable that, if some form of pest were responsible, no sign of its presence should have been at any time detected. It appears probable, therefore, that the nature of the trouble is physiological, and not caused directly by any living organism. In this connection it may be mentioned that there is one side of a biological soil examination which has not yet been made, viz., that concerned with the bacterial flora and the protozoa of the soil. It is yet possible that it may be found that the soils of affected plantations are rendered toxic to the roots of the apple trees during a limited period of the growing season by the production, for example, of injurious substances during that period by a particular type of bacterial activity.

A point which has been observed, and may prove ultimately to be of some significance in connection with the cause of the disease, is that it appears to be only trees growing on cultivated land which are affected. Those growing in grass, so far as information already collected goes, show no scorching of this kind, even when grown in the vicinity of affected trees. The work of Pickering at Woburn has demonstrated that the roots of grasses excrete material which has a toxic influence on the roots of fruit trees and results in many cases in a check to the growth of the latter: but it is evident from what has just been stated that the type of scorching under consideration here is not caused by this action of grass. The action apparently is quite the reverse. A possible explanation is, however, quite conceivable. If the scorching were due to the action of certain soil bacteria, it might be prevented by anything tending to restrict their activity. The excretions of grass roots may, in normal cases, be prejudicial to the growth of trees by an unfavourable action on soil bacteria beneficial to plant growth: but in this particular case they may be actually advantageous on the balance if the hypothetical harmful bacteria are also held in check.

Whether or not conjecture of this sort will prove of any assistance in the discovery of the cause of scorching remains to be seen. There is no direct evidence in its support at present available: but it would accord with the idea which has been met with among growers that the soil is infected with some kind of pest, and account for its gradual spread in an infected plantation from the original centre of attack. It is proposed to investigate the subject further in this direction during the coming summer.

Having failed up to the present to connect the disease with the presence of any pathogenic organism, attention has been confined chiefly to the physiological side of the question and to the examination of various soil and other external conditions which might be concerned.

On the chemical side nothing has been found which in any way suggests a cause. Plantations known to be affected with the disease have been manured by growers in various ways without any beneficial results having been attained, and cases are known where it is evident that the soil has been supplied with an abundance of all constituents required for healthy nutrition. The permanent presence of a toxic substance is unlikely, although it is known that the presence of certain substances in minute quantity in the soil, such, for example, as lithium carbonate, can produce scorching of foliage. No sign of any such body has been observed, and the fact that the affected trees recover from the attack and make healthy growth subsequently in the latter half of the season seems to disprove completely an hypothesis of that nature. The occurrence of a toxic substance in the atmosphere has also been considered, but the presence of perfectly healthy trees in the same and adjoining plantations disproves that idea.

Of the possible physical factors of influence those to which most consideration has been given are soil temperature and moisture, and aerial temperature. The trouble has been reported on somewhat diverse soil types, and the possible influence of the mechanical or chemical composition of the soil and its bearing on temperature and moisture conditions is under investigation.

So far as aerial temperature is concerned, it was considered possible that a spell of cold winds or a sudden chill to the foliage when it was in a susceptible condition early in the growing season might cause local injury to the leaves. Frost damage, for instance, in the form of a certain amount of marginal scorching occurs from time to time. In all cases so far examined, however, the scorching produced by chill appears to remain confined to the parts of the leaves originally attacked and not to spread ultimately over

the entire leaf as in the case under consideration. Partly for this reason, and partly because no relation can be traced between atmospheric variations of temperature and attacks of this disease, it must be concluded that it is improbable that atmospheric temperature is directly concerned. It would also be difficult to account for the gradual spread of the disease through an affected plantation on these lines.

There is more likelihood of soil moisture and soil temperature having some bearing on the case. These factors are so closely related to one another that it is desirable to consider them in conjunction here. After carefully reviewing all the information on the subject which has been collected from various sources it has seemed possible to trace a rather indefinite connection between the occurrence of the disease in a severe form and the prevalence of conditions approaching drought in the soil. For instance, a dry spell of weather in late spring appears usually to be followed by a comparatively severe outbreak of scorching early in June in plantations subject to this trouble. A wet May generally is associated with the postponement of the outbreak until after the drier summer conditions have intervened; and the outbreak may then be slight. A wet spring and summer seems to be unfavourable to the development of scorching. In the case of one plantation which was subject to the disease in a limited form a thorough system of drainage was carried out with the object of improving the soil conditions. Afterwards the scorching developed much more acutely and spread rapidly throughout the plantation. The drier soil conditions or consequent higher soil temperature apparently in this case definitely favoured the disease. Again, the absence of the disease in grass orchards and plantations may be associated with the moister soil conditions due to the presence of the grass.

So far then as available evidence goes, the occurrence of dry soil conditions during the early part of the growing season seems to have some significance in connection with the disease. The volume of reliable evidence at hand, however, is very limited: and further information from growers who have had experience of the trouble is badly needed and would be welcomed. That drought in itself is the sole cause is unlikely: otherwise the driest soils should be most subject to the disease, and this does not accord with the facts.

Experiments were conducted at Long Ashton last season with apple trees in pots to test the effect of various physical conditions in the hope of gaining some direct evidence on the subject. They were directed mainly to show the effects of excessive moisture and drought at the roots, of high and low soil temperatures acting for

limited periods, and of sudden exposure of young foliage to cold. For the most part they were conducted in the orchard house. The results were not very definite, and in no case gave the type of scorching associated with the disease in question. A certain amount of scorching resulted in several cases, mostly on trees which had been suddenly chilled by exposure to cold and on those subjected to conditions of drought. In the former cases the scorching was almost entirely confined to the margins or tips of the leaves, and did not spread. The affected tissues eventually died and withered, and the rest of the leaf subsequently developed normally. In the latter cases the leaves were affected more generally over their whole surfaces, but their development was arrested and they rarely attained full size.

The problem thus still remains unsolved: but the way has been cleared for further investigation, and there is some ground for anticipating that an examination of the biological activities in affected soils, particularly in relation to conditions of moisture and temperature, may throw some light on the subject.

INVESTIGATIONS ON FRUIT CULTURE.

Factors Governing Fruit-bud Formation.

In practical fruit-growing the primary consideration must be the cropping qualities of the trees. Unless these are adequate, financial success is impossible. In the case of apples, pears, plums, and other fruit trees remaining in the land over a lengthy period of years the chief object normally to be aimed at is clearly not the production of a full crop in any one year or during a limited period of years, but of the maximum yield for the full life of the plantation or orchard. At the same time there are occasions when it is important to crop certain trees to the greatest possible extent for a comparatively short terms of years regardless of the effect of this in the future well-being of the trees. This happens commonly in the case of trees planted solely as " fillers " to produce a return while the permanent trees are developing. In either case the fundamental necessity for the grower is to exercise control as far as possible over fruit bud formation, since it is upon this that the crop ultimately depends.

At present it must be admitted that the degree of control attained is very limited and uncertain. On suitable fruit soils and with responsive varieties well furnished trees can be obtained by intelligent pruning and manuring: but there exist many varieties of excellent quality which are not profitable to grow because adequate crops

cannot be obtained, and there are many soils which have to be ruled out of account as fruit soils for the same reason. Considering the lack of definite knowledge of the conditions which govern fruit-bud formation this state of affairs is not surprising, and a thorough investigation of the factors which determine whether the growing point of an active bud shall give rise to floral structures or continue to produce purely vegetative growth is necessary before any material improvement in the degree of control can be anticipated.

Hitherto the grower's command of fruit-bud formation has been mainly through the kind of system of pruning adopted: and it has, in consequence, become customary to attribute the degree with which the tree is furnished with fruit buds to the form of pruning to which it has been subjected, somewhat to the exclusion of any other factors. The result has been that there is a tendency to overrate the part played by pruning and to neglect other possible methods of control. Granted that proper pruning is of the first importance, every grower of experience knows that its nature must be determined by the character of the tree to be dealt with, and that it may require to be varied from tree to tree and from season to season. There is thus no correct general method of pruning which can be universally adopted: and in so far as the results of the numerous pruning experiments which have been conducted at various places are concerned, from the point of view of demonstrating the best methods of pruning all that can be claimed is that they hold for the particular set of conditions under which the experiments in question were conducted. The difference in local conditions doubtless is responsible for the very varied results which have been reported from time to time.

It must be borne in mind that pruning is simply a method by which the course of growth of a tree can be controlled or modified and the distribution of its food supplies directed to respective growing points, dormant or active. The relations of the various centres of growth and the character and amount of the food supply determine the result, and these obviously vary from tree to tree.

It is clear, therefore, that the problems of fruit bud formation will not be elucidated merely by pruning experiments. The factors concerned with the general nutrition of the tree, such as the nature, extent, and variation of the food supplies, the number and relative degrees of vigour of the points of growth, and the mode of distribution and circulation of sap to the various parts of the tree, must be taken into consideration. From the practical point of view, methods of culture affecting these may be at least equally important in their action as pruning. For example, cultural practices modify-

ing or regulating the amount and kind of nutrient substances in the soil, or affecting the water content of the soil, not only during the year as a whole but also at individual periods during the season, are certainly of influence. A system of culture designed to give the best possible results must be based on a proper co-ordination of all the various means bearing on fruit-bud formation which the grower has at his command. To attempt to produce fruit by confining attention too exclusively to a few or a single one of such practices is likely to render the attainment of full success difficult, if not impossible.

In addition to methods of culture regard must be paid to the character of the individual tree itself. The usual type of tree with which the grower has to deal is comprised of at least two distinct parts of different origin, the root system and the stem or branch system. Concerned with the former all the numerous questions related to root stock influence arise: while the latter, which may be either simple or compound in nature according to whether or not the variety grown is worked directly on the root-stock or on an intermediate stock, calls for attention mainly on the lines of variety characteristics and, where necessary, intermediate stock influence. Accounts of investigations in progress at the Station on these subjects have been given in previous Reports, and a further note on them will be found in another section of this Report: so this side of the subject will not be further pursued here.

Observations on various factors affecting fruit bud formation have been made at Long Ashton for some time: and the results of pruning experiments conducted there from time to time, while leading to conclusions as regards pruning methods of little general value in themselves, have provided useful information in preparation for the extension of the investigation of the subject on more general lines which has now been undertaken. Work of this kind must necessarily be extended over a considerable period of years before conclusions of general application can be drawn: but a summary of the position as it stands at present, although concerned primarily with the effect of local conditions at Long Ashton, may serve to throw light on some of the problems met with in other districts.

The conditions at Long Ashton for fruit culture differ materially from those prevalent in the chief fruit-growing areas in this country. While in some respects this is a disadvantage, it seems probable that it will ultimately prove of great assistance to this work on account of the opportunity afforded of comparing the effect of individual factors under different conditions and of thus arriving at their real functions.

Nature of Growth at Long Ashton.—One of the most striking differences between the type of growth made by the plum and apple at Long Ashton and that made in districts which have proved themselves suitable for fruit is the great tendency to form bare, unfurnished wood. That this is not due to any particular methods of culture adopted at the Research Station is proved by the fact that plums and apples growing in the neighbourhood all show the same tendency. It is most marked in the case of the plum, less pronounced in the apple, and but slightly marked in the pear.

During the year the amount of growth made by the terminal buds is good and does not, at first sight, give any indication of want of manure. It might be easily assumed that, with such a sign of healthiness, the trees were growing in the best of conditions, if the tendency to form bare wood and the gradual dying off of many already formed fruit spurs were not so marked.

When, however, the growth of the terminal bud is watched throughout its whole growing season from spring to autumn it is found that there are departures from the normal. Whereas at Woburn, according to measurements made by Pickering, 90 per cent. of the terminal growth has been completed by July 31st, at Long Ashton, on an average, only one-third to two-fifths of the total has been made by that time. The rest of the terminal growth is made after that date. Now, as already stated, the total terminal growth is by no means below that for a normal healthy tree, and thus it is obvious that either growth takes place abnormally quickly after the end of July or it must continue abnormally long into the autumn.

Leaf fall is certainly later than normal at Long Ashton and it takes place very gradually. In mild winters terminal leaves may be seen still attached to apple trees even as late as the beginning of January. Leaf fall in plums occurs about a fortnight later than at Evesham and there is a much longer period between its commencement and its finish. Pears are much nearer normal in this respect.

There is, therefore, no doubt that in the case of plums and apples extension growth continues abnormally late.

In addition, observation brings out the fact that most of the lateral growth made by plums and apples is made after the end of July and is thin and whippy in nature.

There is one other feature of growth that calls for attention and that is the behaviour of the terminal buds in conditions where the "sap pressure" is limited. Where a young tree has been recently planted or in the case of an old tree having many terminal buds to supply with sap, the terminal buds often cease to grow during a summer drought and take on the winter condition tem-

porarily. This would appear to mean that in the young transplanted tree owing to deficient root action, and in the old due to the large number of buds to be supplied, there comes a time during summer drought when the ascent of sap is too limited to admit of further extension growth. Later on, in August and September, when further rains have fallen, terminal growth is renewed, and then continues much later than normal.

In this connection it is interesting to note the growth made by different branches of a fan trained tree. It is commonly assumed that the almost vertical leader gets the most sap, the most horizontal shoots the least, and the intermediate branches intermediate amounts. If this is correct,—and there would seem to be no reason to doubt its accuracy,— the differently inclined branches should show all variations of growth. This is indeed so. The most vertical branches make a continuous uninterrupted growth throughout the season. Those at an angle of about 45° to the vertical make most of their growth before the summer pause and a little late growth afterwards. Those at a greater angle than 45° make more and more early growth in relation to the total growth, and less and less relative late growth till in the horizontal branches no late growth takes place at all and all the wood formed is of a thoroughly well ripened quality.

Thus the vertical shoots are so well supplied with ascending sap that they grow through the summer drought, the horizontal shoots are so poorly supplied that they are completely checked in summer and grow no more in length during the season. Those intermediate between horizontal and vertical have not sufficient sap supply to keep them growing throughout the summer, but too much to allow them to remain without second growth after the check. All the above facts point to the conditions at Long Ashton being such as give a premature check followed by a secondary stimulus to growth. That these are peculiar to, or, at any rate, more than usually marked at Long Ashton will be shown later when considering the meteorological data.

When the first market fruit plantations were planted at the Research Station in the winters of 1904 and 1905 it was arranged that a pruning scheme experiment should be conducted on several varieties of apples. This included among other treatments certain trees which were left entirely unpruned. Before considering the treatment and results on the pruned trees some interesting and instructive information may be gathered from the behaviour of the unpruned trees. Since these were left untreated, they show much more clearly the effect of other external conditions, and from the information thus gained it is possible to interpret the

results obtained by pruning. In Table I. is found the results of measurements taken and counts made during the autumn of 1916. The method adopted was to measure the growths made in each year by one unpruned tree of the variety in question. As many measurements as possible were taken of every year as far back as 1910 before an average was calculated; but it should be pointed out that the older the growth the more difficult it is to be sure which year it is being measured, and that, therefore, the figures relating to remote years are less reliable than those relating to more recent years. Where only one or two measurements could be taken for a given year the results are enclosed in brackets and not included in the total averages.

Taken over the whole period the figures show a gradual diminution in growth length from 1910 to 1916. In 1915 the figures are abnormally low, due to the very severe attack of aphis in that year. Otherwise the diminution is what might be expected from the increasing age of the trees.

The average figures, with four exceptions, hover round 25 cm, (10 inches), although the yearly variations are considerable.

In Table II. are found the figures indicating the average number of laterals produced in each year on the trees whose annual growth measurements are given in Table I.

In computing laterals, all fruit spurs, lateral branches and dead spurs were included, since the object was to obtain figures which should give an idea of the spur-producing power of each variety. As long as the lateral buds break it does not matter from this point of view whether they form fruit spurs, wood spurs or lateral branches, since by suitable treatment it is possible, theoretically at any rate, to transform a lateral growth into a fruit spur. Without a beginning of lateral growth, however, fruit spur formation is out of the question.

The average figures show considerable variation. Good fruiting varieties like Sturmer Pippin, Rival and Lord Derby, come out high, while bad croppers like Lord Hindlip and Houblon are low. Of course good spur formers are not necessarily good croppers, but roughly speaking the two conditions correspond. At the bottom of Table II. are given figures obtained by dividing the average figures from growth in length by the average figures for the number of laterals produced. The figure thus obtained indicates the average length of growth necessary to produce one lateral. This figure is, of course, rather arbitrary, and its meaning cannot be too closely forced home. For hard pruned trees it would be scarcely applicable, but for light pruned trees it would give some indication of the results which might be expected. Lord Hindlip and Houblon again

TABLE I.

Lengths of Annual Shoots. Averages in centimetres.

	Lord Hindlip	Houblon.	Sturmer. Pippin.	Court Pendu Plat.	Wealthy.	Coronation	Rival.	Royal Jubilee.	Potts' Seedling.	Lord Derby.	Frogmore Prolific.
1916 ..	9·7	8·4	21·8	25·7	26·6	25·0	36·7	12·2	12·0	23·0	13·3
1915 ..	8·0	12·3	8·5	13·3	21·0	8·3	7·0	13·0	6·2	14·5	2·0
1914 ..	17·3	22·8	17·8	22·3	43·8	22·2	33·0	19·0	13·2	23·5	22·0
1913 ..	30·9	30·5	21·0	27·0	37·8	31·5	42·7	16·0	41·5	30·2	26·0
1912 ..	34·7	45·5	23·2	30·7	34·7	44·2	49·0	31·2	41·2	40·8	24·3
1911 ..	39·0	44·5	48·2	34·7	31·5	39·5	55·0	34·2	28·0	50·2	15·0
1910 ..	(20·0)	(49·0)	(41·0)	(44·5)		(42·0)				(33·0)	
AVERAGE	23·2	27·3	23·3	25·6	39·0	28·5	37·2	20·9	23·7	30·4	17·2

TABLE II.

Number of Laterals produced per year. Averages.

	Lord Hindlip.	Houblon.	Sturmer Pippin.	Court Pendu Plat.	Wealthy.	Coronation	Rival.	Royal Jubilee.	Potts' Seedling.	Lord Derby.	Frogmore Prolific.
1915 ..	2·0	2·0	4·5	5·0	2·75	3·0	4·75	3·66	3·33	5·0	1·25
1914 ..	2·33	4·0	4·5	8·33	4·75	8·0	4·75	5·33	7·33	8·5	5·5
1913 ..	3·22	4·0	2·0	9·0	11·0	4·5	14·33	4·00	9·0	8·25	11·0
1912 ..	3·77	5·66	5·0	9·33	6·0	4·5	11·0	6·66	6·0	11·0	6·25
1911 ..	5·55	5·0	10·1	9·66	10·0	5·5				12·33	8·5
1910 ..	3·40	2·0	7·0	9·0							4·0
AVERAGE	3·38	3·44	5·18	8·39	6·9	5·1	8·71	4·91	6·41	9·02	6·1
		Average	length	divided	by	average	number	of	laterals.		
	6·9	8·0	4·5	3·0	5·8	5·6	4·3	4·3	3·7	3·3	2·8

come out bottom of the list as regards power of producing laterals, while most of the good croppers come at the top. Sturmer Pippin is an exception owing to its habit of producing strong terminal growth as well as strong development of laterals.

All these figures should not be pressed too far, but they are sufficient to bring one point out clearly, viz., that certain varieties are pronounced terminal growers, while others are much more inclined to the production of laterals.

Besides giving the information as mentioned above the unpruned trees are valuable in indicating under what conditions one may expect to find fruit buds formed. Since no pruning has been done, it is easier to see what are the other conditions necessary. There are two positions in which fruit buds are found on these trees, whether on spurs or not; these are at the end of the previous year's growth and just behind a region which has been attacked by aphis. In each case they are formed when the growth of the terminal bud has been checked. In the first case the check is the natural one coming in the autumn, and in the second the check to the terminal is due to the attack of aphis. In each case the activity of the terminal bud is much reduced and probably as the result the laterals just behind get an increased sap supply. If, however, growth of the terminal is completely stopped, instead of being simply checked, the behaviour of the laterals is different. Instead of growing out into fruit buds or spurs they develop into lateral branches. They then get, so to speak, too much sap. Speaking very roughly, it is possible to have three different conditions, so far as lateral buds are concerned. In the first they receive very little sap and remain dormant, in the second a moderate amount and become fruit buds, and in the third a large amount and grow into branches. (The word "sap" with its vague meaning is used here purposely, since the exact conditions for fruit bud formation are not known, though the approximate conditions have, of course, long been recognised by fruit growers. The authors' ideas on the probable causes influencing fruit bud formation will be discussed in more detail at the end of this paper.)

It is not necessary to give in detail the plan of the pruning experiments begun twelve years ago, but it is sufficient to state that they were designed to throw light on the effect of hard and light winter pruning, root pruning, and summer pruning.

In hard winter pruning two-thirds of the last year's wood was removed; in light, one-third. Summer and root pruning were done according to the usual methods.

The results in most respects were not very definite; and, since in

pruning for fruit the first point is to secure the breaking of laterals, which is usually obtained by winter extension pruning, it is only necessary to consider here the effects of hard and light winter pruning.

It was found that in both cases the number of lateral buds that grew was approximately the same, generally being about four or five.

Thus, for instance, in the hard pruned cases there were perhaps about six or seven good buds left on the last year's wood after pruning. That immediately behind the cut became the terminal for the current year's growth and four or five buds behind it grew out to various extents. The sort of growth that was made may be described as follows. Buds Nos. 2 and 3 (immediately behind the new terminal) would grow into new branches, bud No. 4 into a short wood lateral, bud No. 5 into a fruit spur, and bud No. 6 into a flower bud. Below this one or two poorly developed buds would remain dormant. In the case of the light pruned trees, where perhaps as many as twenty good buds were present after pruning, the top seven buds would behave in the manner explained above, while the thirteen good buds below would remain dormant and would generally eventually die. This resulted in a considerable length of bare, unfurnished wood.

The net result was that practically the same number of laterals and fruit buds were formed by both systems, but the light pruned bushes were considerably larger and made much bare wood.

This result is in striking contrast to that obtained in similar pruning treatments elsewhere, where hard pruned trees form many strong growing wood laterals and light pruned trees become largely covered with fruit buds. The different results obtained at Long Ashton afford one more proof of the desirability of investigating the ultimate cause of fruit bud formation rather than attempting to get information having only a local value by adopting cast iron systems of pruning. There must, of course, be a reason or reasons for the different effects of pruning obtained under Long Ashton conditions and it is possible even now to suggest one, though positive proof has not yet been obtained.

It was pointed out previously that fruit buds or fruit spurs on unpruned trees were generally formed from those buds which were immediately behind a terminal bud which was being checked in growth. Such buds are found either near the end of the year's growth or just behind an aphis check. Neglecting the latter occurrence, for the moment, since it is not a regular feature of the year's growth, it is clear that in these cases the only buds which are easily changeable into fruit buds are just those that would be

removed by winter pruning whether hard or light. The buds which would be left after pruning do not break freely and are not easily changed into fruit buds. If this is so, why do light pruned extension growths on trees grown in other regions show such a strong development of fruit buds? The answer to this would seem to be found in the different behaviour of the terminal bud in the previous year. Whereas terminal growth would appear to have finished by about the middle of August in most fruit growing districts, at Long Ashton it continues until well into September, and often to the end of that month. There is, therefore, no well marked check in established trees until September, a time when both temperature and light are fast decreasing. The lateral buds, therefore, are probably deprived of a full supply of sap until the ripening conditions are bad so that only the buds immediately behind the terminal are well nourished. If this explanation is correct, it should be possible to show that general conditions at Long Ashton are such as would be expected to cause continuous growth throughout August and September; and this, it is claimed, can be shown from a consideration of the meteorological data.

Meteorological Conditions.—Of all meteorological conditions the most important in their effect on plant growth are rainfall, temperature and sunlight.

It is very difficult to find any satisfactory method of measuring temperature effects. It is not a measure of quantity like rainfall, but simply represents a state. It does not measure the quantity of heat received by a body but merely the thermal state that the body has arrived at.

Being a state and not an amount it is influenced by many factors. Air temperature, for instance, is dependent on soil temperature, air humidity, surface winds, radiation from soil, to mention but a few. Again, it is impossible to get any satisfactory figure for air temperature owing to its constant fluctuations. Neither the maximum nor minimum air temperatures give a satisfactory idea of the thermal condition of any day, since the time factor is entirely left out. There may, to take an extreme case, have been a minimum of 32°F. and a maximum of 80°F., and yet the day might have been most of the time neither hot nor cold.

Sunlight is rather more easily measured, since it is possible to find by suitable instruments the number of hours in which the light was sufficiently strong to cause an impression on prepared paper. The time factor and the intensity are thus both allowed for and the figure obtained gives a fairly accurate idea of the quantity.

Rainfall, however, is still easier to gauge, since the actual sub-

stance is caught and measured directly. The zero is clearly defined and is "no rain," while there is no zero point for sunlight and temperature, since everyday there is always some light and heat. If it were known what amounts of light and what temperature limit were the lowest that could affect plants these limits could be adopted as zero; but in the absence of such knowledge sunlight readings and, still more, temperature data are difficult to appreciate. For these reasons more emphasis will be laid on rainfall than on the other two factors.

For the purpose of studying its influence on tree growth it is not necessary to collect rainfall statistics for more than the months of April—September inclusive. By the end of September extension growth has practically ceased, and in any case the effect of rain falling one month will often, though not always, influence the soil moisture for the following. It would, of course, have been more satisfactory to have had records of soil moisture for this investigation rather than rainfall, but the figures are not available.

In Fig. 1 will be found graphs representing the average monthly rainfall (April-September) for the nine-year period 1908-1916 for Long Ashton. The figures for the last four years were obtained from records kept at the Research Station, while the others were kindly supplied by the Long Ashton Court Estate Office, the rain gauge at which is about one mile distant. The two sets of figures are, therefore, fairly comparable. It will be noticed that the figures for June, July and August are rather high, especially that for August, which is over four. The character of the rainfall is brought out much more clearly if the years are divided into wet and dry. For reasons subsequently set forth the total amounts falling during the two months of July and August are used as a criterion. If more than six inches falls during those months, the year is here considered to be wet; if less, dry. By this method 1911 and 1913 appear as dry years, while the rest are wet. That is to say, out of the last nine years there have been two dry and seven wet at Long Ashton.

In the wet years the high amounts for July and August are very noticeable, amounting to as much as 8·28 inches, while for the dry years the corresponding figure is only 1·8. It has been pointed out above that the tendency to form bare wood probably arose from the abnormally long period of growth on the part of the terminal bud. Whereas in most fruit growing districts terminal growth has ceased by the middle of August, at Long Ashton it is usually still active. It would be but natural to expect that the rainfall of July and August would be a factor very largely controlling terminal growth and that much rain would tend to keep the terminal bud

growing, while scant rain, resulting in a dry soil, would cause stoppage. If this is so, it would appear that in seven out of nine years the conditions at Long Ashton are such as to give late terminal growth, and only in two out of nine are they such as to give a satisfactory check.

That over six inches of rain for July and August may be fairly considered as wet for those months is seen from the Woburn figures, kindly supplied by Mr. Spencer Pickering.

In Figs. 2 and 3 these results are represented by graphs. For the total period July and August average only just over two inches each as against 2·8 and 4·04 respectively for Long Ashton. For the sake of comparison graphs for the same years are plotted for the Woburn figures as for the wet and dry years at Long Ashton: but the results of climate are clearer if the years for Woburn are divided into wet and dry on the same lines as those for Long Ashton.

If this is done, the results in Fig. 3 are obtained. Thus only 1912 and 1915 fall into the wet class, while the rest are dry; and instead of having seven wet and two dry years as at Long Ashton, Woburn has had seven dry and two wet.

There is a marked difference between the rainfall in wet and dry years, the totals for a wet July and August at Long Ashton averaging 7·29 inches, but only 3·34 for dry ones.

It has not yet been possible to obtain similar figures for one of the representative fruit growing districts, and it might be contended that Woburn is not a true representative of the normal. Nevertheless, it has been possible, through the great courtesy of Mr. C. Salter, of the British Rainfall Organisation, to obtain some extremely useful statistics of average monthly rainfall at many places in the United Kingdom, some of which are typical fruit-growing centres.

In Table III. a list of eight places are given with 35-year average rainfalls for July and August. It will be seen that the first six, which are fairly representative of certain fruit growing regions, all show between 4·40 and 4·80 inches for the two months. Penzance, which grows mostly vegetables and small fruit, would probably not be very suitable for top trees. Clifton, Glos., which is the nearest centre mentioned to Long Ashton, is as much as 6·53. This figure agree fairly well with that obtained for a nine-year period at Long Ashton, viz., 6·84.

It has, unfortunately, not been possible to obtain figures for Hereford or for any representative place in Kent. Some light on the latter country is thrown by a map illustrating the distribution of fruit in the Weald district, to be found in Hall & Russell's book on "The Agriculture and Soils of Kent, Surrey and Sussex," published by the Board of Agriculture.

FIG 1.

RAINFALL AT LONG ASHTON.

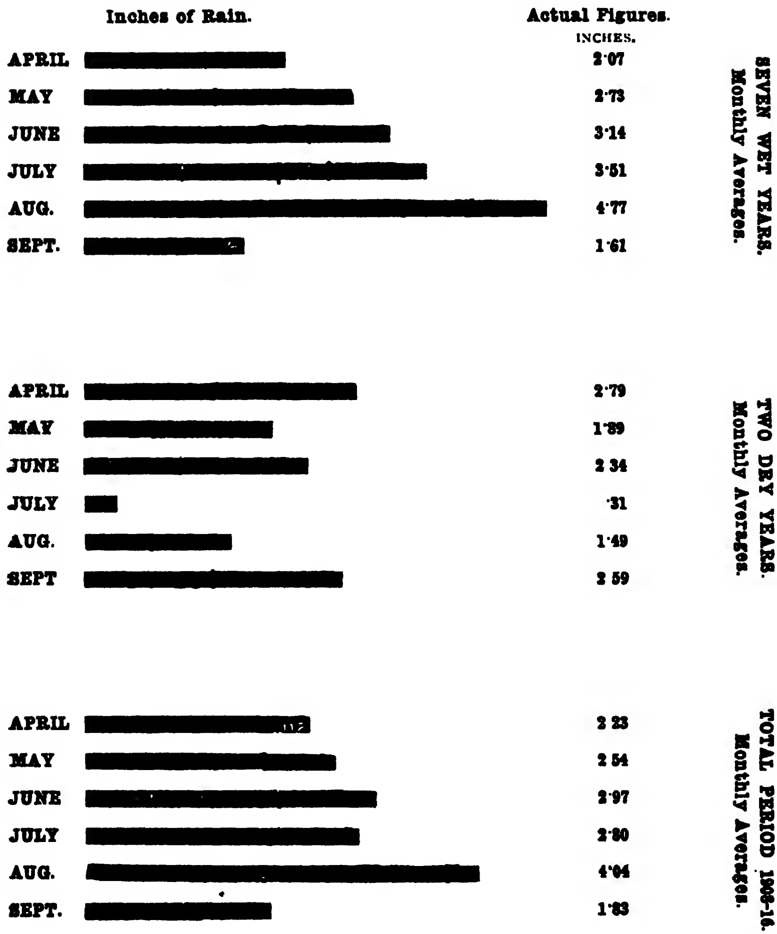


FIG 2.

RAINFALL AT WOBURN.

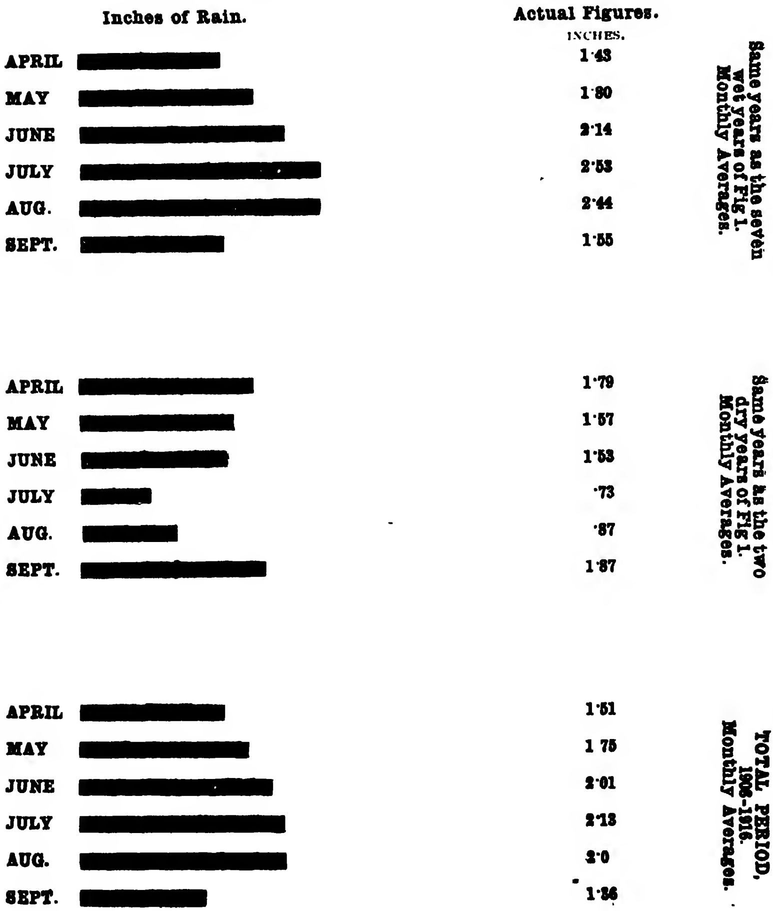


Fig 3.

RAINFALL AT WOBURN.

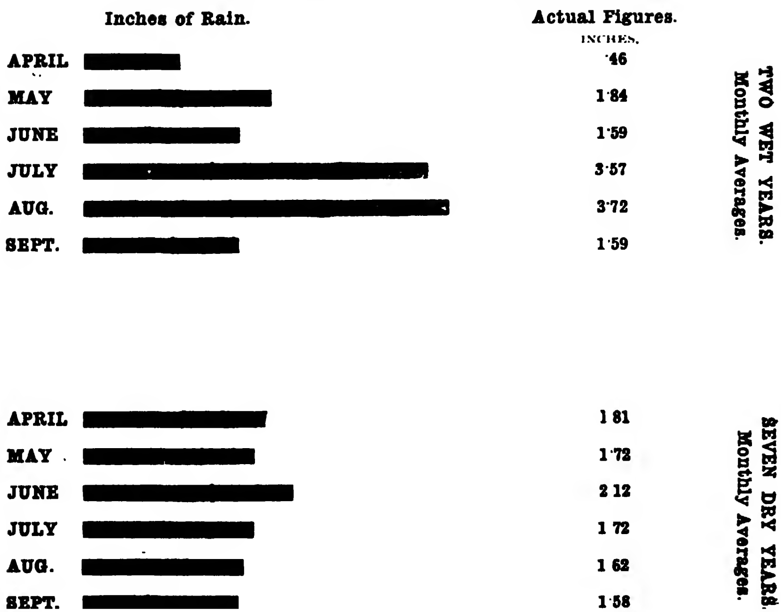
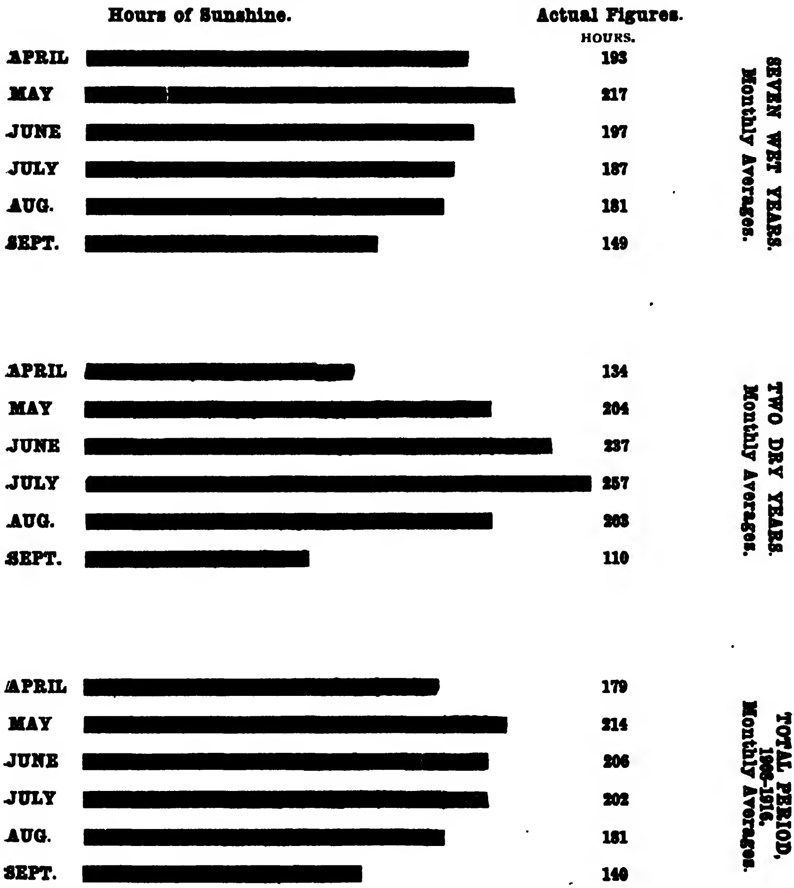


FIG 4.

SUNSHINE AT LONG ASHTON.



This shows that fruit-growing is condensed round centres like Swanley and Maidstone districts which, in those authors' accompanying rainfall map, may be found to lie in regions of low total rainfall.

TABLE III.*

35 YEAR AVERAGE RAINFALL FOR JULY AND AUGUST, 1875–1909.

PLACE.	JULY.	AUGUST.	TOTAL.
Staines, Middlesex	2·21	2·19	4·40
Chelmsford, Essex	2·33	2·27	4·60
Boston, Lincs.	2·35	2·39	4·74
Evesham, Worcestershire	2·12	2·63	4·75
Cherryhinton, Cambridgeshire ..	2·41	2·36	4·77
Exeter, Devon	2·28	2·52	4·80
Penzance, Cornwall	2·95	3·33	6·28
Clifton, Gloucestershire	2·92	3·61	6·53

In Fig. 4 are plotted the graphs representing sunshine records for the same period as Fig. 1. These have been kindly supplied by Mr. Rintoul, of Clifton College, Bristol. These have not the significance of the rainfall figures, but probably have some influence on fruit-bud formation. It is clear that the greater the light, other things being equal, the greater amount of organic food can the leaves manufacture. If, as is likely, the bud in the axil of a leaf is largely fed with organic material (though, of course, not with "crude" sap) by that leaf, then it is important that such buds should be well supplied with organic stuffs in order that, should the other conditions be suitable, they may begin their development into fruit buds. Plentiful light seems, therefore, necessary in order that prospective fruit buds may form.

Put in another way, it may be said that it is probable that for fruit bud formation two things are necessary. Firstly, there must be a tendency for lateral buds to break, as argued before, and, secondly, the food supply (including, of course, manufactured organic material) must be adequate. It would be premature here to discuss the question of food supply in detail owing to lack of sufficient facts, but it is likely that light will prove an important factor.

When the sunlight graphs in Fig. 4 are examined, the most characteristic thing to be seen is the sudden drop in September. This

* Isomeric Rainfall Maps of the British Isles. Mill, H. R. and Salter, C. *Quarterly Journal Royal Meteorological Society*, Vol. xli., No. 173, January, 1915.

is shown in wet, dry and total years, but is most marked in the dry years. September is, therefore, deficient; and, if the terminal growth check does not come till that month, even those lateral buds which get the advantage of this will do so only under conditions of insufficient light and will, therefore, not be so well formed as if the same thing had occurred a month earlier.

Summarizing the meteorological data, one may, therefore, fairly say that the rainfall in seven out of the last nine years at Long Ashton has been of such quantity and so distributed as to be likely to cause continuous growth during August and September, and that when growing conditions are stopped by the fall of temperature there is deficiency of sunlight which would tend to prevent proper "ripening."

Conclusions.—That the usual meteorological conditions prevailing at Long Ashton favour late active vegetative growth and by so doing tend to prevent or delay proper "ripening," is supported by facts which have been noted in connection with the character of the fruit grown locally. Confining attention to apples, which illustrate the case most clearly, it has been observed season after season that for any individual variety in question (*a*) the fruits are late in developing colour, (*b*) when they are ready to be gathered, the degree of colour is poor, (*c*) they do not part readily from the tree until distinctly later than in most fruit districts in this country south of the Trent, and (*d*) their flavour is late in developing, fruits when mature in appearance and texture frequently tasting decidedly unripe. With regard to the latter point a corresponding feature has been repeatedly noticed in the cider made from fruit grown in the district. It has the reputation of being thin and "hungry," even when made from "ripe" fruit of a good vintage variety, such as Kingston Black. This quality is normally associated with cider made from immature and unripe fruit.

The position, therefore, seems as follows. In the average season at Long Ashton active growth continues too late into the autumn for proper maturity to be attained. This is indirectly, if not directly, due to local meteorological conditions, the comparatively wet period of July and August providing sufficient moisture for active growth into the autumn while the temperature remains high enough to favour it and the sunshine from September onwards being inadequate to produce good "ripening." Fruit bud formation suffers in consequence.

This conclusion is entirely in accordance with the old gardening view that after a wet summer the wood is badly "ripened" and a poor crop follows.

The details which the observations have furnished throw now a little more light on the subject of fruit-bud formation. It is evident that, when conditions in the latter half of the growing season favour active extension growth, this is produced at the expense of fruit bud formation. Expressed somewhat differently it amounts to this. Distributed over the whole tree there are numerous growing points, some active, others dormant, each located in a bud. Each, so far as is known, can develop in one of two directions. Either it can form an ordinary vegetative shoot, *i.e.*, produce extension growth, or it can entirely change character and develop into the rudiments of flowers, *i.e.*, produce a fruit bud. In either case the course of development is determined by the nature of the stimulus which causes the multiplication of the cells of which it is composed. (It may do neither, remaining completely inactive. In that event it must be presumed that no stimulus to cell multiplication reaches it.) Since cell multiplication is largely a matter of nutrition, including water supply, it follows that the degree of activity of growth in any growing point of a bud on the tree depends, in part at least, on the supply of sap reaching it.

In the case of trees growing under Long Ashton conditions only a small number of the buds appear to receive the necessary sap supply as compared with trees in good fruit growing districts. The result is a large proportion of bare unfurnished wood. In other words a few buds are relatively well supplied at the expense of the remainder. This, as has been shown, results in comparatively strong extension growth with very little fruit bud formation. Now, since this is associated with a comparatively high rainfall in the latter half of the growing season, and therefore presumably a correspondingly large absorption of water by the tree, the amount of cell sap, or possibly its degree of dilution, seems to be the determining factor in this case, at least between extension growth and fruit bud formation. Moisture conditions evidently affect the distribution of sap among the growing points of the buds, and a free water supply leads to such active extension growth of the relatively small number which are started into growth that the remainder as a whole are left without the necessary supply for development. Strong extension growth, therefore, while it persists, may probably be regarded as indicating an excess of water in the tree.

Considering now the case of fruit districts where the latter half of the growing season is not marked by high rainfall, the trees are better furnished, a larger percentage of buds having developed, and less extension growth is made after the end of July. This

indicates a more even distribution of sap, and the latter is associated presumably with less water in the tree.

The question of water supply thus appears to be of the first importance in relation to fruit bud formation. Many facts, such as the effect of root-pruning, abundant fruit bud formation after a dry season and poor formation after a wet one, could be quoted in support of this view. The manner of its action has not yet been considered. Without definite experimental evidence, which at present is lacking, one can only conjecture; but the most obvious suggestion is that the concentration of the cell-sap is regulated by it and that, therefore, the quality of the food supply to the growing point of the bud is affected. Following the line of argument in the previous paragraphs, it would then seem that when its concentration is comparatively weak extension growth is produced, while higher concentrations lead to a better balance between extension growth and fruit bud formation.

It is not intended to suggest here that the question of the development of individual buds and the course of their subsequent growth is merely a matter of the amount and nature of the sap supply. The whole subject is doubtless exceedingly complex and a number of factors may enter into play. No particular attention has, for instance, been paid in the above line of argument to the question of the degree of readiness with which a dormant bud can be forced into growth. Yet it is known that this differs very considerably with individual buds, and the whole course of growth on any branch system must be affected by the character in this respect of the individual buds upon it. For the sake of the simplification of the discussion, however, all buds have been regarded as equally susceptible to a given stimulus.

The arguments above given are perhaps in themselves sufficient proof of the need for more detailed investigation into the whole question of fruit bud formation. It has been often impossible to use terms other than those such as "sap," "crude sap," "organic materials," which unfortunately have no precise meaning and yet which in our present state of knowledge are all that are available. It will be necessary to bring the question down to the simplest issues before a bed-rock of facts can be obtained.

It is intended to proceed with the investigation at Long Ashton on these lines and to test as far as possible during the coming season the influence of the following and other factors :—

(1) Excess of water in the soil.

(2) Deficiency of water in the soil.

(3) Manures, using artificial ones to avoid other conflicting issues.

(4) Light.

(5) Shade.

SOIL INFLUENCE ON THE COMPOSITION OF STRAWBERRIES.

The question of the chemical composition of fruit is one which has not yet been very exhaustively investigated, especially so far as English varieties of fruit are concerned. With the exception of the studies on the composition of varieties of cider apples and perry pears made at this Station during the past twelve years in continuation of the original work carried on at Butleigh by F. J. Lloyd, little recent work appears to have been done in this country. So far as cider and perry fruit is concerned the chemical composition of the juice is important on account of its bearing on the quality of the cider and perry produced. The more important constituents in that connection are the soluble carbohydrates, malic acid, and tannin. A considerable amount of information as to the character of individual varieties in respect of these substances has been acquired: and it has been proved that, while the composition of a variety varies by no means inconsiderably in individual samples of fruit. being influenced by the nature of the season, the kind of soil on which the fruit was grown, and a number of other factors which need not here be specified, it nevertheless normally varies only between certain limits and approximates to a certain standard, which can be taken to represent the average normal composition of the variety in question. Thus, for example, there are varieties which can be regarded as typically rich in sugars and others as poor in those constituents.

With regard to other varieties of fruit doubtless the same kind of thing holds good, although detailed information is not available. Since the quality of fruit, especially as regards flavour, depends upon its chemical composition, it is evident that, if any attempt to improve the standard of quality of fruit by raising better varieties is to be made, it is desirable not only to learn the approximate standard of composition of individual varieties but also to discover if and how chemical characters are transmitted by breeding. For this reason investigations on the breeding of Strawberries were begun a few years ago at this Station, this fruit being selected on account of the possibility of obtaining results more rapidly than with other types of fruit, the seedlings of which are a longer time in coming into bearing.

Our knowledge of the extent of the variations in the composition of a variety of strawberry and of the factors influencing them is so limited that it was considered desirable to make a series of investigations on the subject before studying in detail the chemistry of the seedlings obtained in the breeding experiments. The present account deals with the examination of a series of strawberry fruits belonging to two selected varieties of fairly marked diverse character which were grown with the object of ascertaining (*a*) the approximate normal composition of the varieties in question, (*b*) variations in composition caused by soil influence, and (*c*) seasonal variations in composition.

The two varieties selected for trial were Royal Sovereign and Epicure. The types of soil on which they were grown were as follows:—(*a*) a course sandy soil from the Bunter beds, (*b*) a medium loam Keuper marl soil, (*c*) a very heavy fine-grained Lower Lias clay soil, (*d*) a black peaty moorland soil with a very high content of organic matter, (*e*) the same as (*d*) with the addition of lime to neutralise acidity.

The original trials were started in the spring of 1914 with young runners of fruiting size, which were planted singly in 6-inch pots in the respective soils selected. The pots were plunged in open ground to equalise conditions of moisture as far as possible.

Ten plants of each variety were used for each type of soil in order to obtain a fair average supply of fruit in the respective cases. The trials were continued over a period of three years, the plants being repotted each year in fresh soil similar to that originally used. During the fruiting season the plants were looked over daily and individual fruits were gathered when they reached, as nearly as could be estimated, a certain standard of ripeness. Those which came from all plants on the same kind of soil at one picking were weighed and analysed together. Since the ripening of the crops extended over a period of two or three weeks, a number of separate analyses of fruit under the same form of treatment had to be made, and a series of results was thus obtained which showed not only the composition of every single picking of fruit but also the variations in composition of the fruit from the same sets of plants throughout the fruiting season.

After numerous trials the following method was finally adopted for the determination of the acidity and sugar in the fruit. It was found to give good comparative results.

The berries after weighing were ground up very thoroughly with water and the liquid made up to a standard volume. After standing for a short time and thorough shaking, a portion of the

liquid was filtered and the acidity of the filtrate determined. For the total sugar, a suitable volume of the filtrate was heated to 70°C with a few drops of concentrated hydrochloric acid in order to complete inversion, neutralised with solid sodium carbonate and titrated with Fehling solution, using Ling and Rendle's ammonium thiosulphate indicator. The analyses were invariably carried through within a few hours of picking the fruit; and for each set of plants a series of five or six analyses was obtained on different dates during the fruiting season.

The average figures only of these duplicate analyses are given in the tables.

In the case of the Royal Sovereign variety these trials were duplicated in 1915 and 1916 with similar sets of plants, which were taken as runners in August, 1914, from the original ones. The runners taken from the plants in sandy soil were in due course potted up in similar sandy soil, those from clay in clay soil, and so on for each soil under trial. The fruit was duly examined as in the above case, but was never mixed with that from the older plants under the corresponding treatment.

In 1914 the Epicure plants did very poorly: as regards the Royal Sovereigns the chief points to notice were the healthy appearance of the plants in the clay soil and the very dark green foliage of those in the peat and lime soil distinctly suggesting the presence of much easily available nitrogen.

In 1915 the Epicures did much better. With both varieties the peat and lime plants came on early, but by the beginning of the fruiting season did not look as well as the others,

In 1916, the third year, none of the plants did very well, and it was a poor season for strawberries. Much the best berries as regards size, colour and quality were on the young plants in medium loam soil.

The following tables show the total crops of each set of plants for each year, and also the average percentages of total sugar and acid in the fruit for those years.

These results, in spite of their indefinite character in many respects, nevertheless show several features of interest.

It is difficult to draw from the crop records any clear conclusions as to soil influence, since the results with the older plants by no means correspond with those from the younger sets. It would probably be misleading to attempt to do so, because in any series of experiments with plants of this size in comparatively small pots it must be almost impossible to keep conditions for growth sufficiently uniform for individual plants over so long a period

THE COMPOSITION OF STRAWBERRIES IN SOIL TRIALS.

Royal Sovereign.

Kind of Soil.	Peat. (a)	Peat. (b)	Peat and Lime. (a)	Peat and Lime. (b)	Sand. (a)	Sand. (b)	Loam. (a)	Loam. (b)	Clay. (a)	Clay. (b)
Crop in grams.										
1914	200	—	150	—	217	—	256	—	326	—
1915	1498	252	1133	524	2002	346	1598	435	1307	282
1916	504	343	263	506	1025	373	599	621	402	61
Percentage of Sugar.										
1914	8·26	—	9·14	—	7·48	—	7·76	—	7·36	—
1915	5·76	5·65	4·91	4·93	5·63	5·63	5·29	5·49	5·75	5·57
1916	6·46	5·59	—	5·04	5·26	5·06	6·42	6·19	5·42	—
Acidity.										
1914	148·9	—	146·1	—	149·6	—	139·6	—	144·9	—
1915	138·8	144·3	126·7	146·8	127·1	138·3	139·9	159·9	144·9	140·6
1916	165·6	123·4	—	116·0	129·4	131·2	145·0	142·7	134·9	—

Epicure.

Kind of Soil.	Peat. (a)	Peat. (b)	Peat and Lime. (a)	Peat and Lime. (b)	Sand. (a)	Sand. (b)	Loam. (a)	Loam. (b)	Clay. (a)	Clay. (b)
Crop in grams.										
1914	80	—	50	—	88	—	130	—	75	—
1915	1286	—	888	—	977	—	1015	—	1167	—
1916	407	—	652	—	933	—	872	—	660	—
Percentage of Sugar.										
1914	9·49	—	—	—	8·48	—	8·49	—	7·5	—
1915	5·24	—	5·4	—	5·44	—	5·32	—	5·25	—
1916	5·04	—	4·97	—	5·05	—	5·47	—	4·83	—
Acidity.										
1914	141·1	—	—	—	112·2	—	109·0	—	108·4	—
1915	86·2	—	92·3	—	95·6	—	94·2	—	90·3	—
1916	87·0	—	88·2	—	82·3	—	99·9	—	92·9	—

The results in Columns (*a*) are those from the original plants: those in Columns (*b*) from runners from those taken in 1914.

The percentage of sugar is the amount of total sugar per 100 grams of fruit, the figure given being the average of determinations made throughout the whole fruiting season.

The acidity is that per 100 grams of fruit expressed in terms of the number of c.c. of decinormal acid. The figure is an average one, as in the case of sugar content.

as three years. At the same time the results clearly tend to show that there is no obvious relation between the size of the crop and the chemical composition of the fruit. Without these statistics of crop yield it would have been uncertain as to the extent to which the variations obtained in sugar content and acidity corresponded with variations in the weight of fruit obtained.

As regards sugar content it is satisfactory to note the close correspondence in the results for the duplicate sets of Royal Sovereign plants in 1915. This cannot have been accidental in so extensive a series of tests, and it indicates, therefore, that they actually possess a definite significance. This correspondence is also continued in the series with sandy and loamy soils in 1916, but the two results with peat for some reason differ widely. It is unfortunate that the remaining two series are not complete, so as to show if this is abnormal. The very close correspondence of the Royal Sovereign and Epicure results for each of the three years is noteworthy. Evidently these varieties normally possess practically the same sugar content. This fact emphasises the importance of seasonal influence on the sugar content, which is very plainly illustrated by a comparison of the 1914 results with those of the two succeeding years. Apparently the nature of the soil has had very little influence upon the sugar content. In only three instances is a striking effect suggested, viz., in the 1914 results with Royal Sovereign on peat and peat plus lime, and with Epicure on peat. The peat plus lime figure in the latter case is, unfortunately, not available. The conclusion is that in years like 1915 and 1916 soil influence, if any, is practically completely swamped by seasonal influence.

The results of the acidity determinations are, on the whole, definite and present several features of interest. In the first place it is evident that there is a marked variety distinction between Royal Sovereign and Epicure in respect of degree of acidity. It is also clear that there is no soil effect sufficiently pronounced in the trials as a whole to show itself in the presence of the other factors concerned. As with the sugar results, seasonal influence appears to swamp other factors. Exceptions to this general conclusion are probably indicated in the peat figures of 1916 for Royal Sovereign and those with the same soil for Epicure in 1914. A definite soil effect seems to have been strongly felt for some reason in those two cases. (There is evidence, when the individual analyses are studied, of a considerable degree of abnormal behaviour on the part of the plants in the peat and peat plus lime series, both for crop and sugar records as well as acidity. This is probably connected with the very high nitrogen content of the peaty soil used.) The

seasonal effect on acidity is well marked in the case of Epicure, 1914 being distinctly different from 1915 and 1916, which gave very similar results. The Royal Sovereign results hardly show this, although in most cases a limited effect can be traced.

The results of the investigation are likely to prove of considerable value in their bearing on the questions which arise in connection with the chemical side of strawberry breeding work. It may be accepted as demonstrated that each variety possesses a definite standard of composition, which can be ascertained if determinations are made in a sufficient number of cases over a period of years to eliminate seasonal influence and individual variations. It also seems clear that, while soil influence can affect the composition of the fruit, its effect in the average case is comparatively limited and more or less completely obscured by seasonal influence. With fruits like the strawberry, which develop and ripen in a comparatively short period of time, it is to be expected that during the course of any one fruiting season, with its daily fluctuations in temperature and rainfall, comparatively large differences in the results of analyses of the individual pickings of fruit will be obtained. For this reason the average results for the season as a whole are given only, complications due to the consideration of fluctuating results shown in the course of a season being thus avoided. The differences in individual results of the same season are, however, so large that a satisfactory interpretation will probably only be obtained after consideration of the daily meteorological records. In future work particular attention to this point will be desirable.

Miscellaneous Notes on Experiments in Fruit Culture.

Fruit Breeding Investigations.—The fruit breeding investigations have proceeded a further step. With types of fruits which are self-fertile, such as strawberries, raspberries, gooseberries and currants, large families of seedlings are being raised by selfing from varieties of commercial importance or of interest from the fruit-growing or scientific point of view. The object here is to ascertain the characters entering into the constitution of these varieties, both in the dominant and recessive form, in order to simplify, if possible, the breeding of fruit on scientific lines in the future. In the case of fruits like apples and plums, the varieties of which are in many instances self-sterile, the raising of families of selfs is not always practicable; and accordingly the same end is being sought by selecting a limited number of types and intercrossing these extensively.

Many of the seedlings of small fruits already raised have now

fruited, and the second generation of seedlings is being grown from these.

The work on strawberries is most advanced, a large number of second generation seedlings having already reached the fruiting stage. Several types of promise have been obtained and these are being propagated for trial on a more extensive scale.

Numerous intercrosses between raspberries and other berries of the Rubus family, such as loganberries and blackberries, have been made, and interesting results from this line of work are anticipated. A few of these hybrid forms are expected to fruit next summer.

Experiments on Plum Trees.—A series of experiments with half-standard plum trees was started in the winter of 1913–14. A large number of varieties were then planted, half of the trees in each case being maidens and the other half already formed half-standards, two and three years old. The main object was to ascertain the influence of the age of the tree at the time of planting on its subsequent growth and cropping quality. The trees have now grown sufficiently to enable a fair idea to be gained on this point. In the case of nearly every variety the older trees have well maintained their advantage in size over those planted as maidens, the only striking exception being in the case of the variety Victoria. The younger trees of this sort are now in size very little behind the older ones. The results of these experiments are probably not so dependable as might be desired, since the trees suffered severely from the heavy hailstorm of July, 1915, the younger ones in particular being badly knocked about : but the differences between the individual trees are sufficiently well-marked to make it seem improbable that another conclusion would have been arrived at if the storm had not intervened.

The opportunity was taken of combining another set of experiments with the former on these trees. One half of the maidens of each variety and one half of the older trees also were cut back at the time of planting (February, 1914), the pruning of the remainder being deferred until a year later, the object being to test with a large number of varieties the much disputed point as to the comparative merits of these two methods. The results differed considerably according to the variety in question. The general conclusion which can now be drawn is that in the case of the stronger growing varieties deferred pruning has produced distinctly the best trees, while for the weaker growing kinds the strongest trees are those which were pruned the same season as planting.

Stock Influence on Fruit Trees.—The investigation on root stocks

which is being conducted in conjunction with the East Malling Fruit Experiment Station has advanced considerably.

In the case of apples, the various types of Paradise stocks which have already been recognised are now being actively propagated, and a sufficient supply to begin the trials contemplated should be available shortly.

The original large collection of free and crab stocks, which has already been classified according to the habit of the root system, is being reduced for further trial to a few types of each class. Information is now available as to the ease of rooting of the individual specimens. While nearly all of the stocks examined have rooted adventitiously under suitable conditions, the difference between individuals in this respect is most marked, some approaching the Paradise type for freedom of rooting and others developing roots very sparsely.

The results obtained up to the present in the intermediate stock trials at Long Ashton do not indicate any marked effect of the intermediate stock upon the chemical quality of the fruit, whatever may prove to be the case with regard to other characters, such as vigour of growth, cropping power, etc., concerning which the information at present available does not warrant definite conclusions being drawn.

In the case of pears and plums the work of collecting, sorting, and propagating types of root stocks is being continued, preliminary to the starting of a series of trials on similar lines to those arranged for apples.

The Prevention of Apple and Pear Scab (*Venturia ina equalis* and *pyrina*).—The spread of these diseases during late spring and early summer has been regarded as largely due to the dispersal of spores from attacked shoots of the trees of the previous season's growth. It was considered possible that if the distribution of these spores could be prevented by the application of a coat of a good cover spray, the serious early summer infection might be considerably checked. Trees of certain varieties of apples and pears subject to attack on the shoots were therefore sprayed with a lime-glue-dichromate cover wash last spring immediately before the trees blossomed. Specially marked results were obtained in the case of Louise Bonne de Jersey pears. The young fruits on the sprayed bushes kept free from scab until the summer was well advanced, when they developed a slight outbreak probably originating from unsprayed bushes in the vicinity. On the unsprayed bushes a much smaller percentage of blossoms set fruit and these were in nearly every case more or less badly scabbed. On many the attack

was so severe that their further development was prevented. They eventually withered and dropped, the prospective crop on that account being much less than on the sprayed trees. The method certainly deserves further trial, especially since the lime treatment is beneficial for other purposes.

The Treatment of American Gooseberry Mildew.— The results of the treatment of an affected plantation in 1915 with the paraffin—soft soap—liver of sulphur spray referred to in the last Report have been very satisfactory. The bushes this season have remained almost free from the disease and very little of the fruit was affected. Unfortunately no convenient plantation in the district available for further trials was found, and the outbreak in the Institute plantations has been practically eradicated. Consequently the work had to be suspended for the season.

The fungicidal properties of the spray fluid in question were, however, tested on a small scale against apple scab and tomato leaf rust (*Cladosporium fulvarum*). In both instances the fungus suffered severely, while the host plants remained practically free from damage except in most of the infected tissues, which were scorched and thus prevented from acting as centres for the extension of the disease.

Cider Fruit For Table Use.

Since the start of the war there has been undoubtedly a large waste of cider fruit. In the seasons of 1914 and 1915 the crops were heavy and prices low: in 1916 the crop generally was short and, although in some districts there was plenty of fruit, the weather was bad and labour scarce. The imposition of a duty on cider has rendered the outlook for the cider-making industry in the immediate future uncertain, and for that reason there has been a falling off in the demand for fruit for cider-making. These causes doubtless have been largely responsible for the waste of fruit and, until the war is over, there seems little likelihood of the whole of the cider fruit crop being utilised for cider-making. Both from the point of view of the grower, and from the wider standpoint of the country generally, the waste of this material of potential food value is to be greatly deplored and should, if possible, be prevented. Regarding the sugar value of the fruit alone for the moment, the total quantity of sugar in the average annual crop is probably not less than 20,000—25,000 tons, about one-fifth of which is cane sugar and the remainder fruit sugar, which, although less sweet than the former, is nevertheless equally useful as food. According to recent estimates the average French crop of cider fruit appears to be about ten times as great as

the English crop ; so in that country, where cider-making also has suffered by the war, the crop represents an equivalent of 200,000 tons or more of sugar.

Attention has, therefore, been given at the Institute to methods of utilising cider fruit for food. Experiments on its feeding value for stock are recorded in the next section of this Report, the present section dealing with its use for human consumption.

The previous two Annual Reports have contained accounts of a method of producing apple jelly without any addition of sugar by simple concentration of the juice. For that purpose the use of a cider press is required for the extraction of the juice. This article is concerned with methods of utilising the fruit for table purposes which are practicable in any home.

Most cider apples are unpalatable to eat in the raw state on account of the leathery texture of the flesh and of a flavour rendered more or less unpleasant by marked astringency or bitterness and a frequent lack of acidity. They have not hitherto been used in the cooked state because of the apparent impossibility of cooking them properly, their tissues remaining tough and leathery even after prolonged boiling. For that reason it has been generally assumed that the average cider apple will not cook.

These remarks apply generally to varieties belonging to the "sweet" and bittersweet" classes. In respect of varieties included in the "sharp" class they need some qualification. Few of these are sufficiently palatable to eat raw, but all cook more or less well. On that account, in seasons when the market apple crop is poor, the larger specimens of these varieties find their way to the market for table use, and large quantities are also used by jam manufacturers.

The problem thus was practically limited to finding a method of utilising the sweet and bittersweet varieties for food. During the course of an investigation on the pectin compounds of the apple certain results were obtained which suggested the idea that the reason why sweet and bittersweet apples will not cook properly is because of the very small amount of acid present in such fruit. A few thin slices of a bittersweet apple were therefore boiled for a few minutes in a dilute solution of tartaric acid to test the effect of the acid. Very quickly it became evident that the slices were beginning to cook properly and in 10 minutes they had become thoroughly softened, translucent in appearance, and partly disintegrated. In less than 15 minutes they were reduced to a fine pulp. Similar slices from the same apples were boiled in water during the same period and at the end were as tough and leathery as before boiling.

It was clear, therefore, that apples of these types could be cooked successfully by the addition of acid. It then remained to be seen if this could be done in such a way as to render the fruit palatable. For that purpose the quantity of acid used must obviously be limited so as not to exceed the amount present in the sharper varieties of culinary apples. Cooking trials were, therefore, made on a larger scale with many varieties of sweet and bittersweet apples, the amount of acid allowed being at the rate of 5 grams of tartaric acid for every kilogramme of fruit, *i.e.*, about one ounce of this acid to 12lbs. of fruit.

The method of cooking adopted in these laboratory trials was as follows. A suitable quantity of fruit was weighed out and the requisite amount of acid also taken. A glass beaker of adequate size was then filled to about one-third of its capacity with water, and the acid dissolved in this. The solution of acid was then brought to the boil over a small gas flame, and kept boiling vigorously throughout the cooking trial. The apples were next dealt with, being peeled, cored, and each cut into five or six pieces, as quickly as possible, the sections being thrown into the boiling liquid as soon as they were prepared. By the time the whole of the fruit had been added the beaker was nearly full and the acid solution just sufficed to cover the fruit. A glass plate was then placed on to check the escape of steam. The boiling was continued until on trial it was found that the fruit was sufficiently cooked. In the case of most varieties from ten to fifteen minutes sufficed : but the exact duration varied somewhat according to the variety of fruit used, its state of ripeness and the thickness of the individual slices. The varieties tested in this way include the following :—Broadleaf Jersey, Cremière, Dabinett, Dove, Ecarlatine, Eggleton Styre, Footlands, Harry Masters' Jersey, Médaille d'Or, Sweet Alford, Truckle, Victoria, and Yarlington Mill Jersey.

So far as quality of cooking was concerned there was not a great amount of difference between the individual varieties. All may be said to have cooked very well. Some required more boiling than others, but this had apparently more to do with the points just mentioned than with any specific variety character. The chief point of variation was the colour of the fruit when cooked. In the details of the method just given it will be noticed that the preparation of the fruit should be done speedily and the cut portions at once thrown into the boiling acid solution. This is desirable, to avoid the discoloration or " browning " of the tissues of the pulp which rapidly sets in with apples of these classes on exposure to air and is due to oxidation of tannins and related substances by

enzyme action, which is prevented by heat. Provided that this discoloration is avoided in the preparation of the fruit, the colour of the cooked fruit is excellent. Many varieties cooked perfectly white: the others showed a faint yellowish tint, which in no way detracted from their appearance.

As regards flavour, leaving out of account the briskness due to the added acid, which corresponds closely enough with the acid taste of a typical culinary variety, there is little that is open to criticism. In all cases the "apple" flavour and aroma are well marked and very agreeable. They appear to be distinctly more pronounced than in the case of most culinary varieties. The "sweet" varieties, and "bittersweets" with comparatively little tannin, present no feature of flavour open to objection and, treated in this way, would pass as culinary fruit to an uninitiated person. With the more pronounced "bittersweets," however, the bitter or astringent tannin character in the flavour, is noticeable, the extent depending upon the amount of tannin contained in the variety in question. To some this feature is not agreeable: but it can be masked to some degree by sweetening the fruit. To others, unless the amount of tannin is very high, its presence is not objectionable.

It will be observed that no mention has been made of the addition of sugar during cooking. In no case should this be done until the fruit is well cooked, because the cooking is impaired. Sugar can then be added to taste. Many will find that little or no sweetening is required, especially if the amount of acid used is somewhat reduced. The natural sweetness of the fruit and the limited acidity tend in any case to reduce the amount of added sugar required.

It is not desirable to reduce the amount of liquid used in the cooking. Well-cooked pulp almost invariably absorbs practically the whole of it: and if less is taken, there is a risk that a part of the fruit may be charred as a result of heating the cooking vessel directly over the source of heat. This can be obviated by using a double vessel, such as an ordinary porridge saucepan: but the temperature is thereby reduced and a longer period of cooking is necessary. For domestic purposes an enamelled saucepan or an aluminium or copper one serves admirably in the place of the glass vessels used in the laboratory trials.

For table purposes the cooked pulp can be used alone or admixed with other fruit as ordinary stewed fruit: or it can be utilised for apple tarts, puddings, etc. In the latter cases it should be cooked as above before being placed in the tart or pudding.

The pulp is equally serviceable for jam or jelly-making, either alone or in combination with other fruit; but it must be cooked

as above before the addition of any sugar. When used for jam-making with other fruit, if the latter is fairly acid the addition of any acid solution is unnecessary, the acidity of the fruit ensuring adequate cooking provided that sufficient is used.

A very simple method of making apple jelly from these apples has been recently worked out. The fruit is placed whole in a convenient vessel and sufficient acid solution is added to partly cover the apples. This is then boiled up and the heating continued until the apples just begin to split. The liquor can then be decanted off clear, or strained through a jelly-bag if preferred, and utilised for making the jelly. Sugar is added to it at the rate of one pound to every pint of the liquor, and any flavouring material can also be added at this stage or during the preliminary cooking, if more convenient. It is then boiled down rapidly until by trial it is found that the concentration is sufficient for it to set on cooling.

By the methods here given it will be seen, therefore, that the whole of the cider fruit crop could, if required, be utilised for human consumption. The most obvious objection against the use of such fruit as food is that of the small size of the individual apples. A very fair proportion of the crop could be obtained in the form of apples of a size which would compare favourably in that respect with many of the cheaper grades of culinary apples regularly found on the market: and a little care in selection and gathering of the fruit is all that is required to furnish a large supply of medium-sized apples. The smaller specimens could be used for jam and jelly-making, if not wanted for cider. Any drawback in respect of size is counterbalanced in any case by the low market value as compared with that of culinary apples.

The Value of Cider Apples and Pomace as Foods for Farm Stock.

The pressed apple pomace obtained as a by-product in cider-making has long been utilised as a food for farm stock, and in years when the cider fruit crop has been heavy and prices low stock have sometimes been turned into the orchards and allowed to feed on the apples. Analyses which have been made from time to time have shown these articles to be possessed of some feeding value, but few serious attempts have been made to test their merits by actual feeding trials. In view of the absolute necessity of utilising all farm products in the most economical way at the present time an experiment was carried out during the cider-making season of 1916

to determine the feeding value of cider apples and pressed pomace. There being no facilities at present at this Station for experiments with live stock, the trials were conducted at the Seale-Hayne College, Newton Abbot. It was found most convenient to conduct the experiments on pigs. The cider fruit used was grown on the College farm, and the pomace was obtained in the early part of the season from the Institute, and later from a local cider-maker.

Stock.—On October 5th, 1916, twenty pigs, varying in live weight from 40 to 69 lbs. each, were sorted into five pens of four pigs each.

Foods.—A mixture of sharps, maize meal and fish meal was the standard food used in all pens, and in four of the five a portion of the sharps was substituted by cider fruit or pomace. The actual amounts of the respective feeding stuffs supplied to each pen will be found in the accompanying tables II. and III.

The analyses of these foods are given in the table following :—

TABLE I.

PERCENTAGE COMPOSITION OF FEEDING STUFFS.

	Apples.	Pomace. (a)	Pomace. (b)	Sharps.	Maize Meal.	Fish Meal.
Water	83·8	67·20	71·75	15·70	14·20	14·9
Protein	·7	1·47	1·70	15·33	9·53	49·1
Fat (Ether Extract) ..	·4	1·90	1·05	4·86	4·08	8·6
Crude Fibre	1·2	13·70	12·22	21·80	2·20	4·3
Carbohydrates ..	13·3	15·17	11·78	38·72	68·66	3·5
Ash	·6	0·56	1·50	3·59	1·33	19·6

The composition of the apples and pomace used varied during the course of the experiment according to the state of ripeness of the fruit and the varieties available at different periods. Consequently the figures given for these in Table I. should be regarded as approximate only. Those for apples are from an analysis by Henry: those for pomace in Column (*a*) from a sample of pomace from Frederick apples, made at the Institute early in October, and sent to Seale-Hayne College for use in the trials ; and those for pomace in Column (*b*) from a sample of pomace obtained from a local farmer there for the trials.

Since no apples were available after December 16th, pomace which had been stored under conditions to prevent decomposition as far as possible was used in their place from that date until the conclusion of the experiment on January 15th, 1917. The trials may, therefore, be considered divisible into two periods, the first from

October 5th to December 15th when apples and pomace were both used, and the second from the latter date until the finish, during which time pomace only was available.

Results.—Table II. shows the amount of the respective foods supplied to each pen of four pigs and the gain in live weight per pen for the first period, and Table III. gives the same information for the respective pens during the second period. No account is taken in the latter case of Pens I. and V., since in both instances one of the four pigs in the pen was obviously doing badly, owing probably to constitutional or individual characteristics, thus preventing a fair estimate of the value of the respective rations being made. For the same reasons the results for those pens during the first period are not satisfactorily comparable with those of the other three pens, the individual pigs in which showed more uniform gain and in live weight.

TABLE II.

PERIOD I., FROM OCTOBER 5TH TO DECEMBER 15TH.

No. of Pen.	Food consumed: in lbs.					Total Fasted Live Weight of Pigs in Pen at start: in lbs.	Gain in Live Weight for 71 days Feeding: in lbs.
	Apples.	Pomace.	Sharps.	Maize Meal.	Fish Meal.		
I. ..	1142¾	—	547¼	390	91	214	300
II. ..	570½	—	669¼	390	91	213	314
III. ..	—	—	771¾	390	91	211	344
IV. ..	73½	251¼	652¼	390	91	212	302
V. ..	35½	355¾	614	390	91	213	307

TABLE III.

PERIOD II., FROM DECEMBER 16TH TO JANUARY 15TH.

No. of Pen.	Food consumed: in lbs.				Total Fasted Live Weight at start of Period II.: in lbs.	Gain in Live Weight for 30¼ days Feeding: in lbs.
	Apples.	Pomace.	Sharps.	Maize Meal.		
II. ..	9	220½	425	302¼	527	144
III. ..	—	—	515	302¼	555	158
IV. ..	—	151¼	454½	302¼	514	159

Conclusions.—Since it is intended to publish a fuller account of the experiments later no attempt will be made here to discuss the results in detail or to examine the financial side: but the following general conclusions appear to be indicated, as far as one is justified

in attempting to base any deductions on the result of a single experiment :—

(*a*) That for fatting pigs of commencing live weights 55 to 60 lbs. per head neither cider apples nor pomace have given as satisfactory increases as meal alone at the relative prices taken for purposes of comparison.

(*b*) That both apples and pomace possess a distinct feeding value and, as shown by the results obtained in Period II, for old pigs, and perhaps for pigs being run on as stores for some time, they are distinctly worthy of the farmer's notice.

(*c*) That from the National point of view at the present time it is advisable that they should be utilised as fully as possible as pig foods.

The Use of Glucose for Jam Making.

It has been suggested by the Board of Agriculture that glucose should be used for jam making instead of cane sugar because of the present difficulty in obtaining this article. At the request of the Board some experiments were carried out on this subject, mostly with Pershore plums. Glucose is on the market in two principal forms, solid glucose and corn syrup or liquid glucose. They contain varying proportions of glucose and maltose, and in some cases dextrin.

The jams were all made from 1lb. of plums, ¾lb. of glucose or cane sugar or mixtures of both, and a little water. These ingredients were mixed, brought to boiling point, and kept boiling for 30 minutes. The various samples gave results as follows :—

(1) White sugar	good jam.
(2) Brown sugar	treacly flavour, not good.
(3) Solid glucose	fairly good, very brisk and somewhat bitter flavour.
(4) Corn syrup	good, but rather acid in flavour.
(5) 1 part solid glucose, 3 parts white sugar	quite good jam.
(6) 1 part solid glucose, 2 parts white sugar	" " "
(7) 1 part solid glucose, 1 part white sugar	" " "
(8) 3 parts solid glucose, 1 part white sugar	fairly good, similar to No. 3.
(9) 1 part corn syrup, 1 part white sugar	good jam.

As a result of this and other experiments, it can be said that both solid and liquid glucose can be used with advantage to replace partly the white sugar ordinarily used for jam-making. The proportions that gave the best results were $\frac{1}{3}$ to $\frac{1}{2}$ of solid or liquid glucose.

As regards colour, the samples made with liquid glucose were lighter than the others.

The jams have been kept for six months and there does not seem to be any difference in the keeping quality when using glucose instead of white sugar. All the samples have kept well and no fermentation or crystallisation has taken place.

ADVISORY WORK.

The total number of enquiries received during the year under review was 205, as compared with 197 for the previous year. This number refers only to applications received through the post and does not include questions raised by visitors to the Institute or received during the course of personal visits to farms. The nature of the enquiries is indicated in the following summary.

Fruit and Fruit Culture.—The purely cultural questions raised have mostly been of an ordinary character and call for little comment. They were concerned chiefly with pollination problems and their bearing on the fertility of varieties, and indicate that growers are beginning to realise the importance of this subject.

The majority of enquiries under this head were concerned with methods of preservation of fruit. Fruit pulping, fruit bottling, the drying of fruit, and the use of glucose for jam-making were the principal subjects on which information was sought.

Diseases and Pests of Plants and Their Treatment.—Numerous enquiries under this head have been received. While in the majority of cases the disease concerned is a common one, there were a few instances in which it is of infrequent occurrence or comparatively little known. Among such may be mentioned examples of *Rhizoctonia* on asparagus; a bacterial disease of cabbage; various fruit spots and an eye rot of apples; "water core" in apples, and "glassy" apples; a modified form of "finger and toe" disease in swedes in which the "finger and toe" fungus, *Plasmodiophora brassicæ*, was associated with another, probably parasitic, fungus; a root disease of Belladonna; and a root disease of apples, probably *Armillaria mellea*. The latter case illustrated very well the risks attendant on establishing a fruit plantation on the site of an old orchard. A similar case has recently occurred at this Institution,

black currants in this instance being the trees attacked. A case of unhealthy tomato plants grown in soil which had been treated with a commercial "soil steriliser" shows the need for care on the part of the grower in using proprietary articles of that kind.

Agricultural Chemistry.—The enquiries under this head have been rather more varied than usual. The subjects dealt with may be summarised as follows :—

The cropping of certain soils.
The treatment and manuring of soils.
Composition of malt kiln sweepings.
Composition of a patent fertiliser.
Identification of a suspected adulterant (Barytes).
Composition of barley meal.
Composition of Chicken guano.
Composition of dried waste from vegetable drying factory.
Composition of snuff offal.
Composition of wood ash.
Composition of milk.
The blackening of potatoes.
The use of sulphate of ammonia.
The eradication of *Genista tinctoria* from pasture land.
The effect of basic slag on rest harrow in grass land.
The effect of sulphate of ammonia on clover.
The use of tan bark ashes for lightening heavy soil.

Cider and Perry Making.– As usual, most of the enquiries received fall under this head. These do not differ greatly in character from year to year and their general nature has already been recorded in previous Reports. The numerous questions submitted as to the utilisation of pressed pomace indicates a tendency on the part of cider-makers to make more profitable use of this by-product. The possibility of the use of cider fruit for jam and jelly making is also evidently receiving more attention.

The chief feature of interest which has arisen is that of establishing co-operative cider factories at suitable centres. A movement in this direction undoubtedly deserves encouragement and, properly developed, should materially improve the cider industry and increase the value of cider orchards.

Enquiries received as to the methods of making "non-alcoholic"

cider demonstrate the prevailing tendency towards the production of a more lightly alcoholic type of cider.

Miscellaneous Enquiries.—Under this head the following may be mentioned :—

The value of *Lotus corniculatus* as a food for cattle, and the best methods of propagation of this plant.

The eradication of *Ranunculus arvensis* from oat fields.

The reversion of oats of the Black Tartar type.

The drying of medicinal herbs.

The preservation of runner beans by salting and the possible loss of food value consequent on this treatment.

The bottling of green peas.

The prevention of granulation in honey.

Mangel Variety Trials.—The trials conducted in the Bristol Province in 1915, and described in the Annual Report of this Station for that year were continued in Worcestershire in 1916 by Mr. R. C. Gaut, Agricultural Organiser for that county. Samples of the roots were analysed at the Station, as in the 1915 trials, and detailed information is given in the accompanying tables for comparison with the results for that year. The particulars relating to the crop yields, soil, etc., at each centre have been kindly furnished by Mr. Gaut.

TABLE I.

Variety and Centre.	Yield. Tons per acre.	% Dry Matter.	Dry Matter. Tons per acre.	% Sugar.	Sugar. Tons per acre.
GOLDEN GLOBE.					
Abberley ..	19·0	12·8	2·44	7·2	1·36
Oakhampton ..	28·2	12·3	3·45	7·4	2·07
Yarhampton ..	26·1	13·1	3·45	8·6	2·27
Lincombe ..	29·5	11·5	3·36	6·7	1·96
Inkberrow ..	26·8	14·0	3·70	8·08	2·14
Average (5 centres)	**25·85**	**12·7**	**3·30**	**7·6**	**1·95**
GOLDEN TANKARD.					
Abberley ..	21·6	11·6	2·5	6·0	1·3
Oakhampton ..	30·5	11·8	3·6	6·4	1·95
Yarhampton ..	27·1	12·4	3·35	7·6	2·06
Lincombe ..	18·0	10·8	1·95	6·0	1·07
Inkberrow ..	23·3	13·3	3·1	7·74	1·8
Average (5 centres)	**24·1**	**12·0**	**2·9**	**6·8**	**1·6**
RED GLOBE.					
Abberley ..	23·05	10·8	2·48	6·2	1·4
Oakhampton ..	42·75	9·6	4·1	5·4	2·3
Yarhampton ..	35·05	11·2	3·9	6·8	2·38
Lincombe ..	23·0	10·4	2·38	6·08	1·4
Inkberrow ..	36·35	12·3	4·47	6·72	2·45
Average (5 centres)	**32·1**	**10·9**	**3·48**	**6·2**	**1·98**
RED INTERMEDIATE.					
Abberley ..	38·9	10·0	3·88	5·5	2·14
Oakhampton ..	42·4	9·4	3·98	5·16	2·18
Yarhampton ..	35·9	10·6	3·8	6·2	2·2
Lincombe ..	32·65	10·0	3·26	5·2	1·7
Inkberrow ..	32·20	11·1	3·57	5·8	1·86
Average (5 centres)	**36·4**	**10·2**	**3·7**	**5·6**	**2·0**
LION INTERMEDIATE.					
Abberley ..	37·45	9·3	3·48	5·28	1·97
Oakhampton ..	43·5	9·0	3·9	5·0	2·17
Yarhampton ..	34·45	10·3	3·55	5·6	1·9
Lincombe ..	30·05	9·1	2·7	5·34	1·6
Inkberrow ..	35·8	10·6	3·8	5·2	1·86
Average (5 centres)	**36·25**	**9·7**	**3·52**	**5·3**	**1·9**
PRIZEWINNER					
Abberley ..	28·1	9·1	2·56	5·5	1·55
Oakhampton ..	51·25	8·8	4·5	4·2	2·15
Yarhampton ..	36·8	10·5	3·86	5·46	2·0
Lincombe ..	25·4	9·78	2·48	5·52	1·4
Inkberrow ..	40·9	10·5	4·3	5·4	2·2
Average (5 centres)	**36·5**	**9·7**	**3·54**	**5·2**	**1·88**
GOLDEN TANKARD.					
Oakhampton ..	30·75	11·6	3·56	5·3	1·6
SMITHFIELD YELLOW GLOBE.					
Oakhampton ..	49·15	10·27	5·05	4·7	2·3

TABLE II.

Centre.	Kind of Soil.	Previous Cropping.	Manuring per acre.
Abberley ..	Fairly deep loam with clay sub-soil.	Oats after mangels	20 tons dung, 4 cwts. fish manure, 4 cwts. superphosphate, 1 cwt. nitrate of soda (after singling).
Oakhampton	Light loam, passing gradually to similar subsoil.	Barley ..	15 tons dung, 3 cwts. superphosphate, 1 cwt. sulphate of ammonia, 5 cwt. salt, 2 cwt. nitrate of soda (after singling).
Yarhampton	Medium brashy nature, passing to similar subsoil.	Barley ..	20 tons dung, 5 cwts. steamed bone meal, 1½ cwts. fowl manure, 1 cwt. nitrate of soda (after singling).
Lincombe ..	Sandy loam, passing gradually to similar subsoil.	Wheat .. following potatoes	1 ton shoddy, 1 cwt. nitrolim, 2 cwts. superphosphate, 4 cwts. salt, 1 cwt. nitrate of soda (after singling).
Inkberrow ..	Sandy loam of fair depth; subsoil stones and rock.	Oats (manured with 8 tons dung per acre)	12 tons dung.

XIII.—ANNUAL REPORT OF CONSULTING CHEMIST FOR 1916.

(Dr. J. A. Voelcker, M.A., F.I.C., etc.)

Eight samples were submitted by Members of the Society for analysis during the past year. These were as follows:—

Oatmeal	1
Middlings	1
Coco-nut meal	1
Soils	3
Lubricating Oil	1
Liquid Manure	1
	8

1. *Feeding Stuffs.*—As regards these three samples there is nothing special to report, all being pure and of good quality.

2. *Soils.*—The three samples were taken in connection with an inspection and general report on a farming estate in Surrey; the main point brought out by the analyses was the poverty of the soil in lime.

3. *Lubricating Oil.*—This had been purchased as Vacuum A Oil, but it was found that, after being used in a motor car, it passed out in the form of a thick grease, which latter was sent me for examination. I found it to contain 70 per cent. of water and to be practically an emulsion of the lubricating oil and water, which latter must have leaked into the oil supply.

4. *Liquid Manure.*—The sample sent of this material consisted of the drainage of a farmyard with discharge from cow-stalls and piggeries, and also the refuse from a suction gas plant. This was found to contain

	Grains per gallon.	
Total solid matters ...	343·84	
Nitrogen ...	25.10	= ·0358 per cent. of the liquid manure.
Phosphoric acid	3·76	= ·0054 " " "
Potash ...	42·34	= ·0605 " " "

This was, as compared with liquid manure generally, a somewhat dilute sample, and, in addition, it contained a considerable amount of sulphur compounds, coming, doubtless, from the gas plant. I should be disposed to regard the utilisation of this on grass land as attended with risk, and consider that such refuse should not be allowed to mingle with drainings from manure heaps, &c.

The Note-Book.

—:o:—

Fashion in Cattle Raising.—The student of the history of cattle-breeding cannot but be struck with the close relation between the evolution of the various recognised or "improved" breeds and the economic conditions that prevailed about the time when our pioneers in breed improvement first started their all-important task. Till well through the eighteenth century the mission of the ox was to be found on the plough land, and the breeds of cattle which were found to produce the best teams of oxen for this heavy work of the farm were the breeds popular among agriculturists.

Then came the great change—the discovery of winter and stall feeding, corresponding to a great economic transition in the industrial conditions of the rapidly growing population. The demand sprang up not only for more meat for the hard-worked toilers, but for a better class of meat. The outlook was studied by men engaged in agricultural pursuits, who set themselves to meet these new and steadily growing requirements. They started on the material at their hand, and began to fashion out of the raw substance which they had that commodity which they saw was to be in demand—flesh from early maturing cattle. The dawn of the "meat-producing" era in Britain wrought a great upheaval, and many far-reaching changes had to be effected. Breeds of cattle which had been so generally "manufactured" to serve certain objects in connection with field culture were not now required. In not a few cases they were found not to answer the new conditions that were demanded to meet the new requirements. Thus, not a few breeds which had become so clearly identified with certain localities as to bear the names of these localities as their "breed" name were swept completely out of existence. Valuable cattle some of these "breeds" must have been, to judge from the accounts which have been handed down to us, but it was a question of "the survival of the fittest"—the development of "breeds" which were found, by the application of scientific methods in breeding, to answer best for furnishing the meat markets of the country.

The old Teeswaters were found to be lacking in uniformity and defective in many important points which commended themselves to the new "school" of breeders as being essential in catering for the fresh objects in view. So they had to be refined, brought

up to a uniform standard, and stamped with the common hall-mark of characteristics which the early pioneers in breed improvement had set up as the model towards which all their efforts were directed. In the north of England cattle history records the disappearance of at least one recognised breed before the onward march of progress. Similarly, in Scotland, with the passing of the droving days, when huge herds of store cattle were driven from the northern counties to the great cattle trysts further south, a breed of cattle was allowed to die out completely, because while it had provided ideal cattle for droving purposes, it did not respond to the new system of feeding which was being inaugurated.

It was well for the country that there were men interested in cattle improvement who had the courage of their convictions. Early Shorthorn breeders urged the lovers of the Hereford that the use of their breed would lead to a further improvement of the Whitefaces, while similarly, in Scotland, the "great intruder" found so firm a foothold, and was so extensively used for crossing purposes, that the native unimproved blackskins were threatened with total extinction. Only the master hand of M'Combie and his dogged perseverance prevented the polled cattle of the north-east of Scotland from sharing the fate of the Aberdeenshire horned breed. But these pioneers were taking no haphazard leap in the dark—cattle history impresses the student with the fact that they had each in view certain definite aims, and although their methods of working were very similar each had thought out for himself the way to attain properties of utility in his chosen breed; each had those properties well defined in his own mind, and had a standard fixed towards which to steer the course of improvement. Thus Bakewell with his Longhorns, the Collings with their Shorthorns, the Tompkins with their Herefords, and M'Combie with the Aberdeen-Angus were marching along pretty much the same road, or a continuation of the same road; and before the idea of pedigree had asserted itself, they were each with their different breeds working towards the improvement of latent properties for greater utilitarian results.

Thus we see that utility was the object in view with these pioneers, and it was in the process of working out their schemes that the idea of pedigree and the system of pedigree breeding were evolved. In any study of pedigree fashion, therefore, it is well to keep in mind that utility was the foster-mother of pedigree, and that so long as the two properties are co-existent, breeders are following on the safe and sure lines which proved so successful in the case of the pioneers. Fashion in pedigree, to these early pioneers, would mean perfection in the utility tests which they were applying,

and in a general sense this is the view that has all along been taken of the idea of fashion in pedigree breeding. But, as history shows, there have been not a few indiscretions by breeders refusing to see that in their pressing after "fashion" they were working away from utility, which was the first great object the pioneers had in view, and a greater object than which no breeder, even with present-day scientific knowledge in all matters kindred to breeding, can ever have before him.

The fact that it was not the building up of "paper" pedigrees, but the breeding of cattle on lines which were believed to give the greatest utilitarian results, is abundantly evident from even a cursory glance through the first stages in the history of modern cattle improvement. The year after Charles Colling returned from Dishley, where he had been making a study of Bakewell's system of breeding, he went to a Darlington market and purchased at the modest sum of £13 his original Duchess cow. He considered her to be the best cow he had ever seen. Similarly, Hugh Watson, a man of surpassing intellect, unlimited perseverance and accurate judgment, selected the best foundation stock he could find, and no doubt in the case of the first Tomkins, who in the second decade of the eighteenth century had entered upon his life's work, the best stock that could be got were secured as a starting point for the new science of cattle breeding. Thus we see that, in the case of the Shorthorn, the Aberdeen-Angus and the Hereford, quality and utility were the characteristics that appealed to the earliest systematic breeders, and it was on these solid foundations that there were reared the first layers in the structure of pedigree. True, it was some time ere the general business of improving the cattle branched off into pedigree lines of breeding, but it is quite easy to conceive how the idea of families, and accordingly of definite lines of breeding, originated, and how it was fostered.

The motto of some of the early breeders was to put the best to the best, regardless of affinity of blood, and in following Hugh Watson's system of breeding we find that he never hesitated to follow the Collings, Booth and Bates in mating closely related animals, practising in-and-in breeding to a considerable extent. Prior to the era of Bakewell such a method of breeding would never have been thought of. It was the inauguration of a new system of cattle breeding, to be conducted on scientific principles much less practised, and not in the blind, haphazard way which had filled the country with heterogenous types of bovine stock. Previously the stock of one district were crossed with stock of an alien breed (or variety), but this mixing of foreign blood now gave way to a union of the

best blood—by which we mean best type—of the same breed. To fix breed characteristics and to impart uniformity of type, the early starters in pure-bred cattle had not a very large selection to work upon, but it was not this that accounted for the systems that were introduced to obtain desired ends. It must be put down as a true feat in the art of breeding that Colling, by following what might appear as an extraordinary course of inbreeding was able to revolutionise ideas connected with cattle-breeding by mating a heifer to her own sire, the produce being the epoch-marking Comet. At a later date we can see what M'Combie did in the development of the Aberdeen-Angus breed. He put Queen Mother to Monarch, and not only was this cow by Panmure and Monarch a son of Panmure, but he was out of a daughter of Panmure. Even greater instances of in-and-in breeding are found in the early history of the Tillyford herd. Just as with Charles Colling, so with M'Combie and with the earliest of the systematic breeders, what was of prime importance was concentration of blood. For no other reason did Colling make three successive crosses of Favourite in his herd, except to gain a concentration of this blood, and to ensure by prepotency that the stamp and breed characteristics thus imparted would make the new race of Shorthorns which he was creating. In following these courses the leaders were not shutting their eyes to the dangers which strewed their paths, and which were later on to ensnare some of their followers. Their excuse for following a system which would to-day be condemned by almost every breeder is summed up by M'Combie thus :—" In-and-in breeding may be pursued for a time until the type is developed, but to continue for any length of time to breed in-and-in is not only against my experience, but, I believe, against nature."

In adopting in-and-in breeding the pioneers were not only, as we believe, seeking to bring about definite results, but they were introducing a complete revolution in the ideas that were generally entertained in these days by breeders of stock. George Calley, in his " Essay on Live Stock " (1786), which was subsequently published by the Board of Agriculture, made reference to this subject. He states that " the great obstacle to the *improvement* of domestic animals seems to have arisen from a common and prevailing idea among breeders that no bull should be used in the same stock more than three years, because (they say) if used longer the breed will be *too near akin* and the produce will be *tender*, *diminutive* and liable to *disorders* ; some have imbibed the prejudice so far as to think it irreligious ; and if they were by chance in the possession of the best breed in the island, would by no means put a male and a female together that had the same sire or were out of the same

dam." "But, fortunately for the public," Mr. Culley proceeds, "there have been men in different lines of breeding whose enlarged minds were not to be bound by vulgar prejudice or long-established modes, and who have proved by many years' experience that such notions are without any foundation. Mr. Bakewell has not had a cross (from any other breed than his own) for upwards of twenty years. His best stock has been bred by the nearest affinities, yet they have not decreased in size, neither are they less hardy nor more liable to disorders; but, on the contrary, have kept in a progressive state of improvement." He goes on to refer to the breed of wild cattle at Chillingham Park, Northumberland, which must indisputably have bred from the nearest affinities in every possible degree, "yet we find these cattle exceedingly hardy, healthy and well-formed, and their size and colour, and many other particulars and peculiarities, the same as they were five hundred years ago."

It can, of course, be argued that what was permissible to the pioneers with their limited selection of material upon which to work ought not to be allowed to present-day breeders with their wide choice in established lines of breeding. There arises now and again a cry for the opening up of certain of the Breed Society's Herd Books, but very often it is found that those who cry most loudly for this are those who bow the knee most devoutly to the Goddess of Fashion in breeding. While the Brothers Colling, the Tompkins, Watson, Fullerton, and others have to be commended for what they accomplished in their various spheres in bringing about fixity of type and definite characteristics by concentration of blood, present-day breeders, while avoiding too close affinities in their breeding schemes, must, if they are to be in the front rank, try to get as great concentration of proved blood as they possibly can. We sometimes take up catalogues and herd books and find therein calves and dams by the same sire. This is a system of breeding that, if intentionally pursued, is to be condemned, and we fear that such cases will be found to be more frequently mistakes than intentional matings. No present-day breeder would attempt to follow the example of the pioneers in their in-breeding. The warning of the Duchesses is a safe enough guard against this being done, one would think.

Mention of the Duchess era opens up a wide field for discussion on this question of fashion in breeding. The writings of Bates abound with strongly expressed opinions. For instance, he would have withheld from Herd Book registration any cattle that had not Hubback's blood in their breeding. It is at the point where Bates took up breeding that the pandering to fashion became more appar-

ent. Perhaps his followers were more to blame than was Bates himself, but fashion was pushed to an extreme. A "craze," as one historian of the Shorthorn breed terms it, set in for stock of the Bates type. Speculators started a traffic in fashionable pedigrees, which ended in disaster. Breeders persisted in the prosecution of in-and-in breeding, and—what was perhaps the worst feature of this slavish worshipping of "fashion"—all animals of the favoured lineage were retained for breeding purposes. Bates himself, by the lines he wrought on, fostered this "craze," for we find him refusing to sell heifers at any price unless the purchaser put them to "bulls I have bred or are of my blood." Within ten years of the great New York Mills sale the Duchess line, through deaths and failures to breed, became extinct in America—a proof that long-continued close breeding tends to impairment of vigour and to infertility.

It is of interest to read the sage remarks of one of our greatest authorities on pedigree breeding as suggested to him by the events of the period we are referring to. The late Mr. John Thornton, in the course of a review of the sales of Shorthorn cattle in 1872, remarked that an objection had been raised against the very high prices that prevailed at some of the sales on the ground that they were paid for animals of certain pedigree, irrespective of great individual merit the animals may themselves possess; yet it was an admitted fact that "the consecutive use of purely-bred males not only perpetuated purity of pedigree, but effects improvement and fixity of type beyond all other methods."

The change in the system so far as regards the Shorthorn breed was brought about by the development of the Scotch type; but in many respects the change has not freed cattle-breeding of the fashion which was so slavishly followed up to the early 'eighties. Just as in the days when the Duchesses were in the heyday of their popularity, and when all sorts and conditions that had the coveted pedigree were kept for breeding, and when blood, not stamina, was what was worked upon, so now there are not wanting indications that fashion in Shorthorn breeding is becoming restricted to a few families. There is danger in the pursuance of a system of this kind. If long-continued breeding in the case of the Duchesses brought about the ruin and extinction of that race, the tendency of such a system must be towards the impairment of vigour and infertility. The "refinement" resulting from the system of breeding practised from the "'fifties" to the "'eighties" prepared the way for the general use almost throughout the Shorthorn-breeding world of the robust, vigorous cattle of Scotland. But it is true of the Shorthorn

breed now, just as it is true of other breeds of cattle, that "fashion" exercises a very great power. At Sittyton less attention was paid to pedigree than to personal merit. If Lancaster Comet and his son Champion of England had been worked on the same lines as Bates' favourites, it would be difficult to conceive what the results would have been. But Amos Cruickshank was well aware of the danger that is apt to arise from too close breeding, although neither Charles Colling with Favourite, Richard Booth with Crown Prince, nor Wilkinson, of Lenton, with Will Honeycomb, carried out the process of stamping their herds with a predominating line of breeding so long or so extensively as Amos Cruickshank.

Since the days of Sittyton the pandering to fashion has steadily grown, and the onlooker cannot help putting the question to himself whether we are not in danger of a "pure Cruickshank" craze which may carry us as far as the "Bates" craze of a former day. It must be confessed that the catering for the foreign, and especially for the United States, market has led breeders far along the road to "fashion." There are no sticklers for pedigree like the United States breeders—a fact which has been seen quite as forcibly in Aberdeen-Angus as in Shorthorn matters. They scrutinise pedigrees with most critical closeness, becoming at times absurdly finical in their fads and fancies. Home breeders are not altogether free of this hypercritical taste. Those who frequent sales have over and over again seen "scraggy" specimens sell at unaccountably large prices—unaccountable to the uninitiated in pedigree fashion. It is, of course, allowed that breeders must to a certain extent follow the fashionable lines in breeding—it takes a man of considerable courage to work on lines which ignore choiceness of breeding. "Fashion" in breeding must always play an important part, and nothing can be said against following "fashion" so long as it is done on sane lines. But when "fashion," and "fashion" alone, becomes the guiding influence—and in too many cases the tendency is strong in this direction—then, as surely as history repeats itself, calamity stands in the way of pedigree cattle breeding. There never was a time since our various breeds of cattle were established when there was more need for giving due attention to questions of individual merit. A strong attack is being made against British prestige in the matter of cattle-breeding. Of that attack no fear need be entertained so long as breeders resolutely set themselves to see that in all questions of breeding merit is enthroned in the chief place, and that pedigree, even of the choicest lines, is made a subservient and not ruling element in breed standards.—J. R. BARCLAY in *Live Stock Journal.*

Calf-Rearing.—There is little doubt but that the modern craving for early maturity has had an injurious effect upon the milk yield of many of our breeds of cattle. In recommending a method which has proved successful with dairy stock it will be necessary to begin with the calf at its birth, and assuming that such calves are the progeny of properly mated parents, it matters but little as regards the method of rearing whether they are heifers or bulls, if the bull calves are intended for service in dairy herds. If the bull calves are "steered," then the early maturity system may be put into practice.

The newly-born calf should be left with its dam for a few days or a week, and allowed to suck at will. This is in accordance with the dictates of nature and will put the system of the youngster into good working order and induce the dam to give her full yield of milk. Certainly the parting may be harder and cause more excitement than if they were parted immediately after birth, but this is more than counterbalanced by both dam and offspring having gained strength. When taken from its dam the calf should get three quarts of its dam's milk per day, given at three meals, and as quickly after it is drawn from the udder as possible. This quantity will be sufficient until the calf is a fortnight old. It may be given from the pail in the ordinary way. The quantity is gradually increased to one gallon per day at a month old, when this may be given at two meals instead of three. Half the new milk may now be substituted by once skimmed milk, or one-third by separated milk, and so on until the new is withdrawn altogether. Where separated milk is used some substitute must be added in lieu of the butter-fat the process abstracts. By this time the calves will begin to pick at a little green hay and nibble at a few pulped roots, if they have the opportunity. If the milk given is of good quality and sweet, and given at a proper and uniform temperature, nothing more should be necessary to maintain them in good healthy, growing condition, and no disposition to lay on fat should be encouraged.

A run out by day as soon as the weather permits assists growth and hardens the constitution. It is absolutely necessary that as the autumn advances young calves should be provided with good shelter and a dry bed, and not be allowed on the pastures after sunset. For this purpose an open shed and small yard answers best, they should not be boxed up. A little supplementary food is also necessary. This should consist of a few sliced roots and as much good hay as they will clear up ; or where roots are not grown, 1lb. of pure linseed cake per head per day will prove a fair substitute for the

roots, or a small quantity of home-grown corn slightly crushed, if more convenient. This diet, a run on the pasture from 9 a.m. to 4 p.m., and a good supply of pure drinking water, should suit them admirably and ward off the various ailments young calves are subject to.

When spring comes, and the young grass begins to shoot, they will soon wean themselves from the supplemental food, and care for themselves. Heifers intended to make ideal dairy cows should be served when about eighteen or twenty months old, so that they drop their first calves when a little over two years old. When it is ascertained that they are safe in calf, then, and not until then, is any forcing diet necessary, for it should be borne in mind that when conception takes place the function of milk production is called into requisition, and a predisposition is set up in favour of supporting the fœtus, and providing milk for the approaching offspring, rather than a disposition to lay on superfluous fat. All points considered the month of August is, perhaps, the best time of year to have young heifers come into the dairy. By this time they have had the full benefit of the early summer's grass to put them in good condition for calving and "making up" their bags. Also by the time they have got over calving and their udders are free from any tendency to inflammation, there should be a good bite at hand to flush their milking capacities to the utmost. They will pay for liberal winter treatment, not only by giving a fair account of themselves at the pail, but because the extra expense incurred will be fully repaid in developing them into valuable additions to the herd.

The present-day custom is to force every calf intended for a bull to the utmost extent from its birth, and such a course is absolutely necessary if they are intended for exhibition. Such treatment, however, tends to defeat the purpose for which they are bred, for if young animals are forced to a state of obesity their constitutions are weakened in more ways than one, and having acquired a tendency to lay on fat, they will transmit that tendency to their offspring, instead of transmitting milk-producing propensities; hence disappointment follows their use. All cattle should be capable of laying on flesh when required to do so, but if we desire to encourage milk production we should so treat our stock by rational rearing and feeding, that such tendency will remain latent until the time comes to develop it.—"C.A.P." in *Agricultural Gazette.*

Height in Horses.—In the eighteenth century breeders were straining every nerve to breed their horses taller. There was great need that this should be done, for our horses, especially

our well-bred horses, were quite on the short side. It would scarcely be correct to say on the small side, because they were wide, with good bone and well developed, but they were certainly wanting in height, and in the second and third quarters of the eighteenth century it is probable that there were more well-bred or thoroughbred horses under 15 hands than over. Probably 14 hands 2 inches instead of 15 hands would be within the mark. In the nineteenth century horses began to grow in height—that is, the increase in height all round soon became marked; and Admiral Rous boasted of the great improvement in our horses, and pointed to an average increase of a hand in height as a proof of it. Since Admiral Rous made this claim there can be no doubt that our light horses all round have deteriorated.

The thoroughbred has grown taller and narrower; and we have seen the same undesirable development in the hunter and other breeds. There has been, indeed, until perhaps quite lately, an absurd prejudice in favour of extremely tall horses, horses that are over 16 hands—and by preference 16 hands 2 inches or even 16 hands 3 inches. Now, no horse in himself is any better for being more than 16 hands high, though it may be desirable that a man who is himself 6ft. 4in. or thereabouts should have a horse an inch or two over the 16 hands limit, for a very tall man is seen to greater advantage on a tall horse, and probably gets over a country better on one. But for all practical purposes 16 hands is as big as is needed. The truth of this is borne out by the experience of many good judges. It was the opinion of the late Mr. Thomas Parrington that the best horse to carry 15 stone to hounds was one standing 15 hands 3 inches, and as nearly thoroughbred as he could be got. Certainly one of the best hunters and weight carriers I ever rode was such a one. And now there comes to me from "Somewhere in France" a strong confirmation of this theory. A friend of mine, who is or who was, in command of a camp of horses, busily engaged in getting them into condition, wrote: "I have no trouble with the horses 15 hands 3 inches; when they get over that height and over 16 hands then the real trouble begins." This practical experience of a fine horseman, who has had hundreds of horses through his hands, cannot be too widely known, as it shows us exactly what the breeder of half-bred horses should aim at.

There is, perhaps, no more difficult task set to the breeder than to breed his horses to a certain height, and this is easily understandable, as naturally when there is a height limit breeders want to get as near to it as possible, so they frequently exceed it. This is the case with Polo pony breeding, and it has been noticed of late

years that there is a marked tendency in Polo ponies to increase in height. Why this should be so is not very easily shown, but I think one reason may be that the modern Polo pony is getting a little away from the pony, and that though the thoroughbred blood which is to be found in him is derived from horses who were of the correct standard, these ponies were descended from taller ancestors. So the question of reversion comes in, and there is " back breeding " to a horse of higher standard, whose name is to be found in the pedigree of the thoroughbred Polo pony sire. That it would be desirable to introduce again a pony cross I am far from suggesting.

The Polo pony breeders are well acquainted with their business as they have sufficiently proved, and the subject is only mentioned to call attention to the difficulties they have to encounter. They are keeping to the 14 hands 2 inches standard, and that is the important thing. It would be a pity to see the standard of the Polo pony unduly raised. In the meantime it is a much more difficult matter than it seems to breed horses of a certain height. If any man who has had a wide experience of horses were asked what he would expect from the mating of a horse over 16 hands with a mare nearly 16 hands he would answer without hesitation a horse from 15 hands 3 inches to 16 hands 1 inch. Yet we find that the produce of Wales (16 hands ½ inch) and Creosote, a well-bred hunter mare (15 hands 3½ inches) is Gwynedd, the champion Polo pony mare at the Royal. Of course, a case like this accentuates the difficulties of the Polo pony breeder. The produce of a mare bred like Gwynedd may all come right in size. For one or more generations they may breed ponies of the right size ; but sooner or later there is sure to be reversion either in the mares or colts.

These difficulties which the breeder has to encounter, show the value of well-kept and authenticated records, a value which he has been slow to recognise in a practical fashion. We have Breed Societies which have done an enormous amount of good to horse breeding, but with, at any rate, a large number of breeders the value of a stud book consists principally of the increased price which entry in the volume enables them to get for their stock. I saw a good deal of the big boom in the horse trade in the eighties, and was satisfied then, and am now, that the real value of the Stud Book was not appreciated. " If my horse is in the book," said many owners, " he will bring £50 more." And so they entered their horses, and were not always too scrupulous about the truth of the statements they made. But what I want to impress is this : that as much as possible should be known and recorded about all horses of a certain standard of excellence that are bred. This is especially

desirable with half-bred horses of hunter type and character, or of the Polo pony type. Now with the Polo pony there is a very great deal of this information, and some of it is forthcoming in the Hunter Stud Book. For instance, the height of many horses is given. But is it too much to ask that the height of every mare should be given? Indeed, the height of the geldings should be stated as well, for when full information is given about them the breeder's problem is much more easily solved. He knows the class of mare that has produced a certain type of horse when mated to a horse of a certain type, and, what is, to my mind, of quite as much if not of more importance, of a certain strain of blood. The more that is known of the history of horses and their ancestry the easier will be the task of the breeders.

It may be urged—indeed, I have heard it urged at times with considerable vehemence—that it is unfair to ask for much information, and that the knowledge, for instance, that there was a strain of carting or Hackney two or three or four generations back would have a prejudicial effect upon a horse's value. I fail to see it myself. We all know well enough that somewhere or other in almost all hunters or harness horses, unless they are Stud Book Cleveland Bays, Yorkshire Coach Horses, or Hackneys, what is known by our American friends as "cold" blood must come in, and does come in; and if we knew exactly where it came in, and how it had been improved, it would not lessen the value of the horse himself, whilst it might and would simplify the task of other breeders to a certain extent. But only to a certain extent. It would be the expert who would be helped; the man who has intelligence enough and who is studious enough to get the best out of the information—a very limited number at the best, as every man of experience knows. If we want a proof of this we have only to look at the thoroughbred. Everything that can be known about a horse is there ready for him who runs to read. The standard is undoubtedly raised by this fact, but the really high-class horses—those that stand out—are as limited in number as they were when there was practically little information at the disposal of breeders.—"THE LOOKER ON" in *Mark Lane Express Almanac.*

Pedigree Stock.—Visitors to modern showyards cannot fail to be impressed by the general excellence of the various specimens of live stock exhibited. When it is considered that all these well-nigh perfect specimens of sheep and cattle have been evolved out of the coarse and shapeless animals which existed in this country in the early part of the last century, it shows how much the excellence of

British live stock is due to the accomplishments of its breeders. Through many generations our breeders have improved and moulded their stock to meet the requirements of the age in which they have lived. Our earliest breeders, the pioneers of pedigree breeding, worked wonders in their generation in improving the ordinary cattle of the time, and from cows and bulls purchased in local markets and from neighbouring farmers the Collings, Booth, and Bates, by their unerring genius and judgment, evolved the greatest of all breeds, the Shorthorn.

When we think of the animals from which the present-day Shorthorn with its true form and shape, rich colour and fine character, as seen in our best specimens in the showyard is descended, we are bound to be struck by the great work our pioneer breeders accomplished in moulding so good an animal out of the coarse, raw-boned and ill-formed specimens at their disposal. They saw the improvements that were needed, and very soon brought them about, and through every successive stage British cattle breeders have always been able to produce the class of animal which the fashion of the period and the public taste have demanded. This applies especially to Shorthorn breeders, inasmuch as in the Shorthorn breed, more than in any other, fashion has changed about, and the type of animal in full favour in one generation has been quite out of fashion in the succeeding one. Yet our breeders can always rise to the occasion, and we find type and characteristics change from time to time without detriment to the breed. All this has been done with animals descended from the original pioneers of the breed without crossing in any way with other distinct breeds, as has in many instances been the case in the production of a new breed or type of sheep.

For many years there has been an enormous drain on our best specimens of the Shorthorn, and it is really surprising to see with what strength the breed comes up year by year when the showyard season begins. There is hardly ever any falling off either in point of numbers or quality, and this emphatically shows the resourcefulness and enterprise of Shorthorn breeders, and that the outlook for them is most encouraging. The two great products for which the breed stands pre-eminent, viz., beef and milk, are both in great demand, and likely to be for many years to come, and, despite their efforts our American friends are not likely to capture the Argentine trade from us.

As the number of breeders of pedigree Shorthorns has increased greatly during the last few years, there is naturally much stronger competition than was the case a few years ago, and moderate specimens nowadays stand a poor chance in public competition.

Breeders must devote all their attention to the production of the type of animal most in demand. The sort that fetches all the money to-day must possess a fashionable pedigree, and must carry that pedigree on its back or in its udder as well. Form, character, colour, and general utility are all looked for in the modern Shorthorn, and although all the chief characteristics cannot by any means always be bred into the same animal, yet the great combination of all the best qualities must be the breeder's aim, and he must keep the showyard type in his eye, for in the showyard fashion is set and honours are awarded to the most perfect specimens of the breed. It is noticeable, too, how much greater attention has been paid in modern times to "utility."

The old-fashioned Shorthorn had much style and character, but was frequently light in flesh, and carried a poor milk vessel, yet, withal, could command a big price if possessed of a long and fashionable pedigree. Not so nowadays. The foreign buyer wants a long pedigree, but he wants beef first and foremost, and also form and colour. The practical home breeder wants beef or milk or a combination of the two, coupled with as good breeding as can be obtained with it, but utility must and should come first.

What is a pure-bred animal without symmetry? Also surely there is no prettier picture to look at than a Shorthorn cow of true shape and "character," with a straight top and under-line, carrying her flesh evenly, with a well-shaped udder carried well forward, with teats correctly placed, and the whole clothed in a fine coat of rich colour?

No animal can possess a wealth of flesh, evenly distributed in the proper places, unless it possesses true formation. If the shape is not correct, then the flesh is not distributed evenly on those parts which produce the best joints. Again, as regards the udder, a badly-shaped one hardly ever secretes the quantity of milk that a correctly shaped one does. It may be that size is being to some extent sacrificed to symmetry, but, then, the public taste is now for small joints and baby beef, whereas in the old days our breeders went for size and scale, form and quality being kept in the background. They in their generation were breeding for the public requirements, when large joints from fully-matured cattle were the order of the day. Some of the eminent breeders of the past sacrificed constitution to pedigree, but in these practical days there is no room for delicate animals, and the fashion of to-day is for cattle showing robust constitution and the ability to make the best use of the food they consume.

There is no place for purely "fancy" stock in these days, and a

wealth of flesh must be found in the beef animal, and a first-class record at the pail in the dairy cow. British cattle breeders have fortunately been able to produce the best of its kind in every breed of live stock. It was never of greater importance than now that they should live up to their reputation. A great deal of our best blood has gone abroad to improve foreign herds, and the owners of these herds are doing their best to take advantage of our present trials and difficulties to capture our trade in pedigree stock, but if British breeders live up to their reputations they will still maintain their supremacy and still obtain the best market for high-class pedigree stock. All the world will still have to come to this country for the wherewithal to improve and keep up the standard of their herds, and our pedigree breeders will no doubt continue to satisfy the demands of the foreigner, the home breeder, the public, and the dictates of fashion. But it is only by means of strict adherence to pedigree that those points which go to make the perfect animal can be propagated, and when we look at what our great breeders have accomplished both in the past and in the present, it shows how great the power and influence of pedigree is in the hands of skilful breeders.—" SALOPIAN " in *Live Stock Journal.*

Maintaining Pure Bred Flocks.—The quality of our home supply of mutton and wool can only be kept up to its present standard by the maintenance of our pure-bred flocks. If the supply of pure-bred rams falls short of our requirements our sheep stock as a whole will rapidly decline in value, and breeders of cross-breds would soon be in a sorry plight.

There is a strong inducement to cross-breeding, for it is generally acknowledged that first crosses (preferably between two pure breeds) will beat any other cross or pure breed, therefore it is obviously necessary and very desirable to maintain as many pure breeds as possible if only for this special purpose. It is a very common custom to cross ordinary ewes with a pure-bred ram of another breed for the production of fat lambs and butchers' sheep, and excellent results follow, as a cross-bred invariably matures more quickly than other sheep, with the exception, perhaps, of the very best pure-bred. To obtain the best results it is essential that the ram should be of pure breed, and the longer and the more carefully bred the flock from whence it is obtained the greater will the sire impress his good qualities on his offspring. It is largely for the supply of such rams for crossing that the maintenance of our pure-bred flocks is of such national importance.

All the world has in the past come to Great Britain for pedigree

stock, and in the future the demand is likely to increase greatly owing to depleted stocks the world over, and to the probability, amounting almost to a certainty, that high prices for meat will rule for some years to come. The world's markets are large, and are likely to be larger. British breeds of sheep have established a reputation far and near, and it is heartily to be hoped that the position will be upheld. Breeders of pure-bred sheep will then be amply rewarded for having done their best to stem the tide of indiscriminate breeding, for every pedigree animal exported incidentally assists in keeping the balance of trade favourable to this country. The country needs money, and for many years to come the same condition will prevail, and the more money we can get from outside the better. To enable us to do this our pure breeds must be maintained at full strength, sufficient to meet home demands and supply the export trade.

Even admitted that other countries will eventually produce sheep of the highest class, it is found in practice that the type and prominent characteristics of sheep undergo considerable change when they are removed to different varieties of soil and climatic conditions. It will ever be necessary from time to time to go back to the original stock to preserve the character and valuable characteristics of the breed, and to correct the natural tendency to atavism or mediocrity.

The question as to whether the average farmer can get better monetary returns from cross-breeding than from a pure-bred flock depends largely upon the nature of the holding—*i.e.*, whether it is really a farm which will carry sheep at all seasons of the year and under practically any climatic conditions. In certain cases—and these conditions apply to a number of mixed holdings—a flying or cross-bred flock is most suitable, but, in my opinion, on many farms now running cross-breds a pure-breed (not necessarily pedigree) would in a series of years help to maintain the fertility of the land and give a better return than the course now adopted

Prices to-day are abnormal, and should not be quoted to prove or disprove anything, but the fact remains that even in normal times store ewes are often so dear to buy in the autumn that the profits to be derived can be largely discounted.

A man who possesses a flock of pure-bred unregistered sheep kept for the special purpose of producing high-class mutton is always more or less self-contained, and the high prices breeders and feeders are now compelled to pay to re-stock their holdings should point to the wisdom of breeding some of the animals necessary for the equipment of the farm. In the case of pure-bred flocks market fluctua-

tions have not the same bearing, and the returns in a series of years are governed by the law of average.

Many reasons might be assigned for the extension of cross-breeding. Some practical men maintain, however, that some breeders have cultivated fancy points at the expense of the essential ones. Others have crossed with the one object of obtaining size, entirely forgetful of the output of mutton per acre, and the fact that medium weights, owing to public demand for small joints, make the highest price per lb. The larger and coarser sheep is usually a great consumer in proportion to mutton produced, but a sort of pride on the part of some farmers to obtain top price in their local markets obscures the judgment of really good men as to whether they are actually getting the best returns from their sheep.

There is undoubtedly a tendency amongst farmers to go in for big sheep, because the tegs when marketed realise perhaps 8s. to 12s. per head more than medium weights, but do those men who favour the very big sheep take all the pros and cons into consideration before adopting this course? In the case of big sheep they are undoubtedly large consumers, and where a flock of 100 breeding ewes of the big type are kept some 125 to 140 of the smaller or medium type of ewes can be run on the same farm. The question the practical man has to consider is which type gives the best monetary return per acre, taking into consideration the price obtained for the finished article and the cost of production.

From the foregoing and other causes, the breeding of pure-bred sheep is going out of favour. This is much to be regretted, for it is a distinct national loss, and breeders of cross-bred sheep will in the long run be considerably affected by it because to obtain the best results pure breeds must be available, and to continue breeding by mating cross-breeds is never considered desirable.

The question is, what inducement can be held out to the enterprising farmers of to-day to undertake a national duty and do their bit to maintain in numbers and quality the great inheritance which has been handed down to them—viz., our pure-bred flocks of sheep, running into some 30 varieties, the majority of which are serving a useful purpose?

I have thought over and discussed this interesting problem with several practical men, and the consensus of opinion is that a pure-bred flock, if managed on right lines, will show quite as good annual monetary results as a cross-bred one, and at the same time gradually but surely improve the capital value of the farm stock. To take an illustration:—A young man is starting life as a farmer. He probably does not wish, or think it wise, to go in for a show-yard

career, with its attendant trouble and expense, but should he not, as a practical farmer (a national asset) take up at least one pure breed of animals with the intention of breeding them pure? If he is able to make his pure flock pay as well as cross-breds, or even if for a year or two the balance is in favour of cross-breds, the advantages are very great as time goes on. According to the success of the breeder the value of the flock is ever increasing, and a first-class form of life insurance is secured without paying a premium. The fluctuations of the fat and store market do not so greatly disturb the man who has a good home-bred stock. Other assets include the pleasure and interest attached to pure breeding, the education one incidentally acquires, and the friends and acquaintances made in every country in the world, all of which are considerations not to be disregarded.—ALFRED MANSELL, in a paper read to the National Sheep-Breeders' Association.

Wild White Clover.—It has long been known that cultivated leguminous plants like clovers, beans, and peas, cannot be grown continuously, or even frequently, on land without the land becoming clover-sick, bean-sick, or pea-sick. The reasons for this have exercised the minds of agricultural scientists. Lawes and Gilbert at Rothamsted, endeavoured to grow such crops continuously on small plots, but found this to be practically impossible. They also endeavoured to grow clover continuously on a rich garden soil, but even under such favourable conditions the crops ultimately became weaker. They came to the conclusion that when land is not yet clover-sick, the crop may frequently be increased by manuring with salts of potash and superphosphate of lime, but that, when land is clover-sick, none of the ordinary manures, whether artificial or natural, can be relied upon to secure a crop, and that the only way is to wait some years before repeating clover on the same land. Liebig, in "The Natural Laws of Husbandry" (1863), criticised these conclusions, and suggested that Lawes and Gilbert had not exhausted all the means that might have been employed to restore the clover productiveness of a clover-sick field, and suggested that the lower layers of the soil were probably not sufficiently stored with plant food. It has been found, however, that no method of manuring will make a clover-sick field grow clover satisfactorily, Leaflet No. 271 of the Board of Agriculture, on clover-sickness, states that the old idea that clover-sickness is due to the exhaustion of some soil constituent essential for the growth of clover is now disproved, and that it has been definitely shown that the disease is of parasitic origin. Eelworm attack and sclerotinia disease are discussed in this leaflet. The former, but not the latter, has been frequently

found on decaying red clover plants at Cockle Park. Ordinary red clover and white clover die off very quickly there, but wild white clover retains its permanent character, and eelworm attack has not been found on this plant at that station...

In 1886, the Royal, Manchester, Liverpool, and North Lancashire Agricultural Societies commenced trials of grasses and clovers at Broughton Hall, near Chester. The writer was shown these plots by the late Mr. Thomas Rigby in 1891. At that time, where ordinary white clover had been sown in 1886, there were practically no white clover plants present, but where wild white clover had been sown, at the same time, there was a perfect carpet of white clover plants. It was evident that wild white clover seed had produced perennial plants, whereas the ordinary white clover seed had not done so. The former had been collected from old and natural pastures in Kent. At that time the writer had frequently walked over the Great Orme headland at Llandudno, where, on the thin soil lying on limestone rock, natural clover and other leguminous herbage was abundant. This herbage must have been growing on the Great Orme not for one year, or ten years, or a hundred years, but for a much longer time, and yet these wild plants showed no signs of clover sickness. Trials with wild white clover were commenced at Aber, Carnarvonshire, by the writer in 1893, as he was convinced that if wild clover plants could be obtained for cultivation, the difficulty of clover sickness would be surmounted. As, however, the writer moved to Reading in 1894, where the growth of leguminous plants did not present the same difficulties, these trials were not followed up. Moving, however, to the North of England in 1902, he came in contact with the difficulty at Cockle Park of growing clovers. Practically all the cultivated clovers died off within eighteen months from being sown. There was generally no difficulty in obtaining a good clover take with the young seeds, but in most cases by the following April the clovers began to die off, and it was only occasionally that red clover lasted sufficiently long to produce a good crop in first year's hay, and seldom lasted longer than the aftermath of the first season.

An article by Mr. Frank T. Shutt, Dominion Experimental Farms, Canada, published in 1900, showed that a vigorous crop of red clover would produce in its first year's growth over nine tons of green herbage per acre, containing as much nitrogen as there is in about 5½ cwt. nitrate of soda. He also found that the partly decayed material on the surface of the ground, and the roots to a depth of four feet, contained nitrogen equivalent to nearly 4 cwt. nitrate of soda an acre,

Thus the successful growth of clover meant not only the securing of crops of clovers, but, as a result, a great enrichment of the soil in nitrogen, the most expensive manurial ingredient to the farmer. A determined effort was therefore made to secure these two great advantages by the growth of a wild leguminous plant. Wild white clover was selected for this purpose, more especially because in the Tree Field pasture trials it had been found that the excellent results from basic slag were due mainly to its marvellous effect in developing the natural wild white clover which existed in the poor, untreated pasture in a very small form.

In the spring of 1906, on a stiff and poor clay soil of no value, plots, each one-quarter acre in area were, after summer fallow, sown with wheat and a seeds mixture which included wild white clover. Owing to the wet autumn, the wheat was harvested with great difficulty, because of the extreme softness of the clay soil. Half a ton an acre of high-grade basic slag was applied that autumn. By the following midsummer the wild white clover where sown (4lb. an acre) was spreading most satisfactorily over the plots, and by the autumn this was practically the only clover left on any of the plots, the cultivated clovers, red clover, Alsike clover, and ordinary white clover having died out. A plot sown with cocksfoot grass, with just a little Italian rye-grass, showed small and weak cocksfoot plants in June, 1907, whereas the cocksfoot sown with wild white clover was vigorous and had a dark green colour at that time, thus showing that grasses could very quickly benefit from association with clover, no doubt owing to the nitrogen collected by the latter. The plot on which wild white clover was sown, along with cocksfoot, Timothy, and perennial rye-grass, has produced nearly 35 cwt. hay an acre annually for the past ten years, whereas a similar seeds mixture with wild white clover omitted has produced only about 23 cwt. an acre annually. The effect of the inclusion of wild white clover was not only to secure a vigorous and healthy growth of white clover, but to obtain at the same time a healthy growth of the grasses, because of their association with this clover. On the plot on which no wild white clover was sown the grasses have been much weaker in the earlier years, but are now becoming vigorous over most of the plot, owing to plants of natural white clover having gradually asserted themselves. The intermediate stage, therefore, between the time the seeds were sown and the accumulation of the natural herbage with clover has been most efficiently bridged by the inclusion of wild white clover. Ten hundredweight an acre of high-grade basic slag has been applied every third year since 1906, when the first dressing was applied.

In the following year three acres of poor and stiff clay soil were sown away with correspondingly favourable results, this area being still cropped with hay annually. On an average, 36 cwt. of hay an acre has been produced in the past nine years, as well as valuable aftermaths with an abundance of clover in each year. The only manure applied has been 10 cwt. an acre of high-grade basic slag every third year. The heavy soils at Cockle Park are now cropped on a six-course rotation, and seeds hay is grown for three of the years. In the early winter, after each barley harvest, 10 cwt. an acre of high-grade basic slag (39 per cent. phosphates) are applied to the young seeds. On the average over two tons of hay an acre are obtained in each of the three years, as well as valuable clover aftermaths. The seeds mixture used per acre is somewhat as follows :—

16lb. Perennial ryegrass.
10lb. New Zealand cocksfoot.
4lb. Timothy.
4lb. Singlecut cowgrass clover.
1½ to 4lb. Wild white clover.

Mr. George Wood, Hazelton, Glos., has obtained excellent results from the inclusion of wild white clover in seed mixtures. A field on his farm was sown with a wild white clover mixture about five years ago, and this field is now fattening a bullock to the acre. A good pasture was obtained in the season after sowing, and it has since continued to be an excellent pasture. Suitable dressings of basic slag have been used.

Mr. James Cruickshank, Errollstone, Cruden Bay, Aberdeenshire, began sowing wild white clover, 1lb. an acre, in his seeds mixtures in 1910, and has now sown many of his fields with seeds mixtures containing this plant, all developing well. He reported in 1913 that one of these fields gave a close and green sward till the end of the grazing season, and he estimated that it produced double the amount of pasture of any field on the farm. Mr. Cruickshank makes good use of basic slag to develop the wild white clover.

On poor down pasture land in Sussex, on a thin soil with chalk underneath, Dr. Somerville sowed a small quantity of wild white clover as a renovating seeds mixture on a broad strip which had been treated with basic slag. The seeds have taken in a striking manner, and the part sown with wild white clover can easily be distinguished from the remainder of the field, because of the improved pasture. When the clover is in flower, its white appearance is very marked.

Mr. J. P. F. Bell, Fulforth, co. Durham, has obtained on large

areas most satisfactory crops of hay and aftermaths on temporary leys. In 1915, he had eighty acres of oats, after two years' ley with wild white clover, which gave an average yield of 11 quarters an acre. The writer was invited by Mr. Thomas Temperley, Riding Mill, Newcastle-upon-Tyne, to inspect four farms on Tyneside this season, on which oats were growing after temporary leys with and without wild white clover. It was estimated that the oat crop had been increased per acre, as a result of the inclusion of wild white clover in the seeds mixtures, by 35 bushels at Willimoteswick, and by 20 bushels at Throckley South Farm, Newburn. At West Wharmley, Hexham, the oats after wild white clover were estimated at 88 bushels an acre, and the crop, under similar conditions, was also a very heavy one at Thornton Towers Farm, Fouristones.

These results are of a most striking character, and show the marvellous effect of wild white clover in improving the fertility of the soil and in increasing its content of nitrogen, especially when assisted by basic slag. Reports are being received not only from the North of England, but from all over the country, as to similar results, and the good effects of wild white clover roots are found not to be confined to the crops which immediately follow the leys, but continue throughout the rotation. At Cockle Park, in 1915, up to 36 tons an acre of swedes were grown. The only manure used for the swedes was 12 tons dung an acre, but the seeds hay two years previously included wild white and other clovers, and these had been most satisfactorily developed by basic slag. The better crops now grown throughout the rotation at Cockle Park are largely due to the judicious use of wild white clover and basic slag.

It is of the greatest importance that the seed of true wild white clover should be obtained. This is now being produced from natural pastures, on which wild white clover has usually been developed by basic slag, not only in Kent and in other south-eastern counties, but largely in Gloucestershire, and, in suitable seasons, even as far north as Northumberland. It is also found that "once-grown" wild white clover seed gives as satisfactory results as "original" seed. "Once-grown" seed is obtained by sowing "original" seed under suitable conditions, and treating the ley by basic slag and otherwise, so as to develop clover rather than grasses. Great care should be taken by seedsmen and by farmers in purchasing seed that wild white clover is not more than "once-grown," as its tendency must be to approach the cultivated condition by continuing to grow the seed under cultivated conditions for a few generations. Owing to the present high cost of seed, it may be desirable to limit the amount of seed to 1lb. an

acre, but demand must ultimately bring about a full supply of this seed, and there are indications at Cockle Park that if up to 2lb. an acre can be sown, a close and even sward of wild white clover will be formed more quickly.

At Cockle Park, the large parties of farmers, who visit the station usually express great surprise that the excellent leys of three years' duration, produced from a wild white clover mixture, are broken up. The object is to bring poor, heavy land into a suitable cropping rotation, and, as already stated, the realisation of this has been helped to a marvellous extent by the inclusion of wild white clover in the seeds mixture, and by the judicious use of basic slag. That these leys would make an excellent basis for permanent pasture has been shown by the fact that in one case the ley has been down for ten years, has always been of a most satisfactory character, and continues to improve rather than otherwise. At Cockle Park the grasses best suited for sowing with wild white clover are perennial rye-grass, cocksfoot, and Timothy. New Zealand cocksfoot is preferred, as it produces more leafy herbage, and is about ten days later in maturing than cocksfoot from other sources. Other grasses, like meadow fescue, were originally included, but are now omitted, as they did not grow successfully at Cockle Park. The striking results which have been obtained right over Britain from the north to the south, by including wild white clover in an otherwise suitable mixture, fully demonstrate that large areas of land can thus be successfully sown, and excellent pastures at once obtained. This is especially so for large areas of poor pasture land, which could be most efficiently improved by ploughing, taking a crop of oats, and sowing immediately with a suitable seeds mixture containing wild white clover. Basic slag should also be judiciously applied. For the light classes of soils a potash manure, when available, should be used, in conjunction with basic slag. Till this is available, a dressing of dung (with which the urine has been incorporated, as this is rich in potash) should be applied to the ley before ploughing. Neither nitrogenous manures nor dung should be applied to the young seeds, as these encourage grasses at the expense of the clovers, and so hinder the development of a typical wild white clover pasture. It is important to note that one of the great advantages of wild white clover for laying down permanent pasture is that a close sward of clover is quickly formed, which at once nourishes the grasses sown with it, thus practically preventing what has been one of the greatest difficulties met with in the past in the formation of new pasture, the development of a weedy herbage in the first few years.

A typical wild white clover pasture requires to be seen to realise its possibilities. The grasses, suitable to the district, should be sown with wild white clover. Too large a proportion of grass seeds will considerably retard clover development. On soils not rich in phosphates 10 cwt. an acre of high-grade basic slag (37 per cent. of total phosphates or upwards), applied to the young seeds when the corn crop is removed, has given excellent results for three years thereafter on the heavy loam soils at Cockle Park. Five hundredweight of basic slag an acre every third year thereafter will probably be ample to keep the pasture in good condition.—PROF. D. GILCHRIST in *Farmer and Stockbreeder Year Book.*

Blackface Sheep.—Dr. Wm. Watson, of Glasgow, recently gave a lecture on the above subject from which we take the following :—

Fashion means some arbitrary unreasoned, unstable condition liable to change from caprice alone. That there have been changes in the type of Blackface is true, but that these have not been governed by fashion or caprice it is my intention to prove. Rather have we one long successful story of how patient, intelligent men have added to the wealth of others, and to that of their country, by improvements as laudable as making two blades of grass grow where only one grew before. The progress in perfecting the Black face sheep of this country has had its big forward movement and also times when things appeared to be less satisfactory. That improvement has been great, and when there was any appearance of backward movement there was a ready reason for it, and a speedy cure. Nature responds readily to the control of the human brain, but the production of man's ambition may bring with it something undesirable. It is this that in the end often proves a barrier against his attainment of perfection, and yet makes the breeding of any animal as attractive as the hunt for the philosopher's stone was to the scientists of old, and as the hunt for wealth is to the financier of to-day.

What was the point aimed at during all these changes? High and low in the scale of the vertebrates, from man downwards, there are fundamental principles in the construction of a good animal. The first of these is a good constitution. Into the making of this many things enter, and when we have settled these we shall have arrived at what is the desirable type of Blackface from which to breed. To begin with, it must have a framework constructed on the best mechanical principles with due regard to all work being carried on with the maximum of production and the minimum of cost. It must have all its parts of locomotion placed mathe-

matically correct that it may move with the greatest possible freedom, and it must be arranged with the fullest economy as regards space and with the greatest provision for carrying on all work vital to it. It must, therefore, have ample room for its lungs and heart, and for the organs of alimentation, and as few corners or prominences as possible distant from the central pump which drives the heating and nourishing fluid through its body. It likewise must be of a size commensurate with the food supplies available for its growth and sustenance, otherwise it will be like the man who builds too big a house for his income—he will never have anything to put to a reserve—and an animal like this is not wanted by any man. Domestic animals may be divided into three classes, those for (1) Speed, *e.g.*, Thoroughbred horses; (2) draft, *e.g.*, Clydesdales and weight-carrying horses; (3) meat production, and, as a sub-section of this, milk production, *e.g.*, cattle and sheep. Even with such a variety of animals and types the above-named fundamental principles hold. In the Thoroughbred and Clydesdale the joints must be accurately fitting, and the leverage such as to produce the greatest effect. In both there must be economical production of power and a capacity for storing a reserve for the special work of each. In cattle and sheep the same holds good, only the power here is transferable. and capable of being stored as a reserve, either in the form of flesh or milk production. It is a common saying that a good Blackface tup should be built like a Clydesdale horse. Up to this point the comparison holds good, but it must end here. The breed we are considering is a more natural product – a breed which has to find its own food, and that food all home-produced, for in talking about Blackface sheep we must not be carried away by the glamour of the tup sales, the weights at the fat stock shows, or the cry of the cross-lamb breeder. Our attention must be fixed on the heaths and mountains and we must turn for a moment to the history of the breed.

About 1768 a great discovery was made which revolutionised the Highland districts of Scotland perhaps to a greater extent than anything else ever did. It was the discovery that the Blackface heath breed of sheep could live on the Highland hills unfolded and untended at night. These hills were formerly one vast wilderness untenanted by anything useful save the deer and the grouse, and these were a prey to predatory animals. There were sheep and cattle, but these were confined to the lower edges of the hills, where they were pastured and tended from the shielings during six weeks in summer. All along the high ridges and hill-tops no domestic animals grazed. The cattle were lean and scraggy, and we may judge of the value of

the sheep from the records in the Black Book of Taymouth, where it is stated that it took the clip of 27 sheep to make one stone of wool. These were small, long-legged animals with coats more like hair than wool, and so delicate that they had to be folded at night. The introduction of a type that could live and thrive in the highest mountains, and which could raise the revenue of the Highlands by millions of pounds annually, was surely a discovery. Sir John Sinclair, writing in his Statistical Accounts of Scotland about thirty years later, calculated that before the introduction of sheep farming all the produce exported from the Highlands did not exceed £300,000 from lean and poor cattle, whereas at his time of writing with sheep, wool and woollens manufactured therefrom, it exceeded £4,200,000. To carry on this great industry, which has been the source of such material health and comfort to mankind, we must consider what the type of animal must be which has to live and thrive on the highest, bleakest, coldest, and most barren land in our country. Virility is the first thing to be desired, and to have virility we must study the formation of the animal which is to live there. The size must be commensurate with the food provided, and it must have activity to search for food over a wide area of steep and difficult country. Therefore its bones and joints must be placed as mechanically perfect as possible. Its backbone must be straight to the tail head, strong and unyielding, its shoulder blades sloping and lying close to its ribs, but not meeting at the top. Its shoulder joints must be deep set and firm, with straight, strong forearms and big knees set wide enough to clear a deep and large brisket. Its pelvic bones must be large, strong, and roomy, and they must be well carried up. The thigh bones must be powerful, set into deep sockets and firmly held by strong, thick muscles. The hocks must be fine and clean, but strong and wide set, with elasticity to give the sheep a free, graceful swinging stride. Its shank bones must be hard dense, flat, and strong, and it must have a good sloping pastern, with big, springy, well-made feet. Its neck must have length sufficient to give it grace of carriage, but well set into the shoulder at a proper angle. It must have wide, well-sprung, deep ribs, especially behind the shoulder blades, to give room for a big heart and free play to its lungs. When we clothe this bony framework with its soft structures, we find that the more perfect the mechanical construction of the animal is the more flesh in the shape of muscle it will carry for its size, likewise it will put on condition and keep condition much better than a more imperfectly made animal. So far I have said nothing as to the length of leg. An animal made on these lines may have any length of leg. What we want is a big

animal when it is lying, or when it appears hung up as a carcase, and, after all, perhaps the shanks are the cheapest part of a sheep. Size in a living animal is often a deceptive thing. A thoroughly proportioned animal never looks big. You never know the size of a good horse until you stand up to him. There are no angles or points to catch the eye and make the animal appear bigger than he really is. But there are other things we must look for in a sheep as indications of virility. It must have a fearless, clear eye; in the male full of the boldness of challenge, and in the female eloquent of the tenderness of motherhood. The nostrils must be large and open, and freely moveable, and the mouth square in front and big, with a full under jaw. The angle of the lower jaw must be large, thick, and covered with powerful muscles. Likewise the nasal bone should be prominent, making a gentle but graceful arch between the eyes and these should be set widely apart. In this way we shall have the best formation for a free supply of air to the lungs and an apparatus for providing a large and quick supply of food to the stomach. It must have ample storage capacity for its food, which is bulky and watery, and therefore it must have a capacious abdomen, with strong muscles to support it and prevent it breaking down and getting baggy. Finally, it must be well clad, for, considering its wet and cold habitat, and the necessity for its doing more than merely living, it cannot afford to lose any energy in the form of heat. In the realisation of these aims we have a reason for what is regarded as essentials in the characteristic sheep of to-day.

Now, let us consider in what way the changes of the type of Blackfaces have in any way deviated from this standard. When the revenue of our hill grazings was enormously raised by stocking them with sheep, we had not an animal like the present type to work with; we had something much more akin to the goat or deer. It is difficult to form a clear picture of what these sheep were like. We have now had an opportunity of contrasting the old and the new, and of summing up what we have gained and what we have lost. We have gained quality, width, depth, and wool. We have lost height. Have we lost size? This question of size is so important that we have to consider it with some care. To have conformation such as we desire, it was necessary to shorten and to widen the old type of sheep, and the breeders that we have mentioned have been successful in doing this, but to do so meant a succession of generations of sheep bred with this end in view, and in the attainment of it there was a certain risk of fixing a smaller type. A tup should not be regarded as the index of a stock, but as the pioneer of improvements in that stock. Hill land is not meant to produce

replicas of our show tups. But it can produce similar shapes and tendencies which in the feeders' hands, will be capable of causing early and easy fattening of wedders, not fit for immediate slaughter, and of old ewes. The continued breeding of sheep on these lines might influence the size of the stock of their breeder, but they must have had a wonderful influence in improving stocks throughout the country where their improved conformation would be of great benefit to the producers in the way of much more early marketable lambs. It is said to-day that sheep are much smaller than they used to be, and that breeders are making a fearful mistake. It is difficult to trace the signs of poverty in the appearance of sheep breeders at the present time, but perhaps the times are exceptional.

Let us then see if there is any fault that could be removed which would benefit him in more adverse markets. It is a short story the putting of sheep on to the Highland hills. When they went there the land was new, and they were exceptionally healthy. In a great portion of the southern area, cultivation having been more or less carried out on almost every dry portion of hill land, sheep there did equally well, but as even a hen-run gets foul or a field will not in two consecutive years continue to rear healthy pheasants, so the continual stocking of land with sheep will affect them adversely. It is impossible for all land to carry the numbers it carried at one time. The size of the sheep becomes proportionate to the food supply available. Unfortunately, in many cases this is further reduced by the enormous increase in brackens. Sheep have a strong preference for certain pastures, and these are excessively eaten as long as they last, and thus tend to get foul. Liming, once so common, is now owing to its cost much less used, but the use of it would renew such pastures, and this, with proper attention to the burning of heather and coarse grasses, would do much to increase the supply and quality of food available. Many of the sheep farms in the south were formerly dairy farms. When sheep were put on them at first they throve very well and the lambs were large and heavy. Now they are back to Nature. The rents are heavy; men are loth to reduce the stocking, and so there has naturally come about a marked decrease in the size of the sheep they carry.

One other question we have got to consider. We have enormously increased the quantity of wool grown. The average clip of the hill ewe must be at least 3lb. greater than it was. Wool is formed from food by the conversion of practically the same elements as cause the growth of bone, of flesh and horn. Considering the limited supply of food, the raw material for the production of growth on the sheep is limited, and if you breed for skins you must

be prepared for a reduction in the size of sheep. The framework of a sheep should not be bred larger than can be more than maintained by the food supply available. It is as easy to breed large sheep as small. Provide sufficient and efficient food, and the difficulty of size will never be a troublesome one. Nature is always fair in her dealings. If large sheep are desired, then there must be a reduction in the stock, and it is for a man to consider whether he will have 75 large sheep or 100 small ones on the same ground. But as a sheep can be too large and rough, it is equally true that it can be too small and fine. Want of height can be pardoned if there is width, but when there is neither height, width nor depth, then there is danger to the purchaser in proportion to the purity of lineage of the sheep. In other words, the more highly bred the animal is which has glaring faults, the more likely will it be to fix these faults on its progeny.

We have dealt with the bony framework of a sheep and the flesh it carries. Another point not so generally considered is its nervous system, and here we come to that important thing—quality. This may be defined as the perfect appreciation by an animal of its surroundings, and is what tact or gentlemanliness is to a man. Its movements are well regulated, it has complete control of itself, and there is in its appearance an unconscious dignity. This is the expression of a perfectly-balanced nervous system and is a governing factor in health and development, and therefore greatly to be desired.

The next question that arises is probably the most thorny of all, especially at the present moment. I refer to wool. Considering that wool prices are practically the same for all classes of wool, and that there was a ready and usually profitable demand by manufacturers for strong skins, and that the clip of these was heavier, it is not surprising that breeders strove to produce them. There are several questions, however, which face us to-day, and demand an answer. Have we lost more in money. (1) Through the reduction of mutton owing to the additional growth of wool? (2) By the chance from international considerations of losing a profitable market? (3) By the increased difficulty of dealing with sheep on a snowy country? (4) By a larger percentage of death amongst lambs from their failing to find the teat behind such a dense and deep curtain, especially in gimmers? (5) By a decrease in the number of lambs from tup yeld ewes? (6) By inability to detect malformations in the design of a sheep through the coat being so long and dense as to obscure everything? I say unhesitatingly that the change must be made in the wool of the sheep in future, and for these reasons.

As I have stated before, it is impossible to expect Nature with the same material at her disposal to produce a greatly increased growth of wool without lessening the weight of the carcase. There are variations in the price of mutton, but never so violent as those in the price of wool. There is, and always will be, a market for mutton; whether we can depend in a future on the market for wool is another question. If there is any recession in the advancement of Blackface breeding, I think wool is responsible for it. It is stated that since the introduction of strong skins wedder lambs are short in weight by 1¼lb. per leg. If that is so, does the increased wool make up for the deficiency?

With the chance of an improvement in the size of the sheep, the supplying of manufacturers here with a wool they have long asked for, and the acquisition of a more or less steady home market, the question of the future type of wool requires the most careful consideration. There are many drawbacks to the heavy skins, and even a smaller clip and a better price might be more profitable to the sheep breeder.

There is the question of increase in size that might follow the adoption of a different class of wool, and there is likewise the importance in the wintering of sheep in a country liable to heavy snowfalls. The question is whether we are to shorten the length of wool or increase the length of leg of the sheep, and, in my opinion, the alteration in the length of the coat is the more desirable of the two. Exactly the same drawback exists in connection with nursing, and it looks as if there had been an attempt to foil nature by so studiously covering up the organs of nutrition. If there has been one difficulty more than another placed before the ordinary breeder in the selection of a suitable sire, it has been the exhibition of ordinary sheep at our annual sales with such long covering coats. There are degrees of bandy legs and knock knees, but it would take a very acute eye to detect anything but gross malformation under a voluminous skirt, and it is almost impossible to tell exactly how a sheep is planted when it is exhibited in this form. The consequence is that many imperfections have crept into the ordinary hill stocks, and one of the chief and most deplorable of these is the confirmed tendency to droopiness in the hind quarters.

Wool is a non-conducting material, and is meant to prevent the radiation of heat from the body of the animal. The strong skin feels coarse and hard to the touch, and when opened exhibits a very open texture. Contrast it with a fine skin when opened, and there are certainly five fibres to one in the fine as compared with the strong. It stands to reason, then, that what is the best covering

for the sheep is a skin which is as thickly planted as possible. The length should be regulated by two considerations—the difficulty amongst snow, and the manufacturers' objection to too long a staple. If we could then get a shorter, much more thickly planted coat, of a much finer texture, we should have a sheep that would be at least as healthy, probably larger in size, and a better nurse, and wool which would claim a greater variety of markets than the present wool can to-day.—*The Scottish Farmer.*

Feeding Standards.—Although feeding standards are often looked upon by farmers as a kind of scientific fad, they are really the most practical and useful aids that could be conceived in connection with the feeding of live stock. The farmer has constantly to make up his mind as to the proper quantities of different foods that should be given to his animals. The shepherd has to be told how much cake he may give to the ewes, the fattening tegs or the lambs, and the farmer has also to determine what that cake shall be. The horsekeeper wants more corn for his horses, and the question has to be discussed and settled; the cake and meal have to be bought for the dairy cows, and the allowance per head must be fixed; the proper quantities of straw, roots, and cake must be determined upon for the fattening cattle, and in all cases the quantities of food allowed must be sufficient for the purpose in view, and at the same time waste must be avoided if the business is to be profitable. The farmer, therefore, fixes certain feeding standards from his own experience, and, if that experience is considerable, and he is dealing with foods he knows, the feeding standards will in most cases be fairly correct. They may, of course, be less than they should be, and this is soon shown by loss of condition, poor milk yield, or slow gain in fat, or they may be too large, in which case the animal does well, but there is no method of knowing how much is being wasted, for the animal is not a machine and cannot utilise profitably more than a certain amount of food.

It was the knowledge of these facts, and the certainty that in many cases no previous experience was available in fixing the correct amount of food for any particular animal, or the best quantity of some particular food, that led to the attempt to fix certain standards for different kinds of live stock. The first attempt appears to have been made by Thaer, in 1810, when he introduced what were known as "hay equivalents." In these the supposed feeding value of the various feeding stuffs was expressed in pounds of hay, and it was used as a method of comparing foods for several years. It is still found in certain agricultural books, but it was never satisfactory,

as it is impossible to compare with hay such diverse foods as linseed cake and roots with any reasonable degree of accuracy.

Some years later, when the composition of foods became better known and the methods of analysis had become improved, attempts were made to formulate standards from the chemical composition of the foods. It was not, however, until 1864, as the result of the investigations of Henneburg and others, that Wolff brought out his feeding standards based upon chemical composition and digestibility. These standards, in the light of several years of practical experience, were gradually improved, and the Wolff-Lehmann standards of the nutrients required by 1,000lbs. live weight of any kind of live stock have held the field for many years.

As a matter of fact, Wolff's standards have proved themselves to be remarkably correct in practice, and it is quite a common experience to find that if a farmer is using a ration for his fattening cattle or dairy cows that proves particularly satisfactory and economical, and it is worked out to show the albuminoids, carbohydrates and fats it is supplying, it will agree fairly closely with the proper quantities laid down in the standards for animals of that class. These standards were based on numerous experiments of a very complex character, designed to show exactly how much of any particular food was digested and what became of the digested portion. The result was that certain quantities of digestible albuminoids (protein), carbohydrates and fats were found to be essential for certain purposes, and on these the standards were fixed. As examples it may be stated that the food of a dairy cow weighing 1,000lbs. and giving two gallons of milk should, by Wolff's standards, contain 2½lbs. of digestible albuminoids, 12½lbs. of digestible carbohydrates, and ½lb. of digestible fat, while that of a fattening bullock of the same weight should contain 2½lbs. of albuminoids, 15lbs. of carbohydrates, and ½lb. of fat.

Within the last few years other methods of calculating the standards for feeding have been introduced. Armsby, in the United States, has based his on the energy-producing power of the foods, less the amount of energy expended in masticating and digesting the food, and has expressed the net available energy of the foods in what he calls "therms," the standard rations being based on the number of therms required. Kellner, a German investigator, has also based his standards on the energy-producing power of the foods, and has used as his unit the amount of energy available from 1lb. of digestible starch. The energy-producing power of the different foods is then calculated and stated as "starch-equivalents"—that is, in terms of the amount of energy they are capable of producing, using the

energy produced by 1lb. of starch as the unit. It is found, for example, that the starch equivalent of average hay is 31, of average oat straw 19, and of linseed cake 77. The feeding standards are then calculated to show the amount of digestible protein (albuminoid) and starch-equivalent necessary for each class of animal for 1,000lbs. live weight.

Some difference of opinion still exists amongst scientists, as well as amongst practical men who have adopted the scientific methods of feeding, as to which of these methods of calculating the feeding standards is the better. The Wolff standards have stood the test of years, and, with certain modifications to fit them to British stock and methods, have given excellent results in thousands of cases. The Kellner method, adopted by certain British scientists, is possbily based on correct science, but would appear to require a considerable amount of modification and alteration in some of the standards to meet British conditions. These adjustments have already been made from practical experience in many cases, but there is one point that should be remembered if confusion is to be avoided between the two sets of standards. It is that when the Wolff standards are to be used, the Wolff tables of the average digestible constituents of the food should also be used in working out the proper quantities of albuminoids, carbohydrates and fats in the ration, and, on the other hand, if the Kellner standards are adopted, then Kellner's tables of digestible constituents should be used in working out the proportions of proteins or albuminoids, and the starch equivalent. The reason is that in Wolff's tables the percentages of digestible albuminoids includes the amides of the food, while in Kellner's tables these amides are excluded. Whether the amides should be included or excluded is a purely scientific matter, and does not concern the practical farmer at present, but confusion often arises as to the different figures quoted as the digestible constituents of certain foods, such as hay and roots, and this is the reason.

It is, however, an undoubted fact, that, whichever set of standards is adopted, feeding based upon the standards gives better and more economical results than the ordinary haphazard and rule-of-thumb methods. Thousands of pounds are thrown away every year in feeding to live stock rations containing far more albuminoids, or carbohydrates, or fats than they can possibly utilise, this waste being more common with regard to carbohydrates or starchy foods than anything else. There is also the waste of keeping cows that milk badly, young stock that grows slowly, or horses that cannot work properly for want of a little more of some particular nutrient in their food, while the health of the animals is often seriously

injured by badly balanced rations. No one contemplates that all the foods served out to animals shall be weighed to half an ounce or to exact decimals of a pound, but it is exceedingly easy to calculate out a ration for any animal or class of animals that shall agree fairly nearly with the standard that has been proved by years of practical experience to give the best results. If this were done more often the great majority of farmers would find that they had been wasting foods and that a considerable saving could be effected.—" W.M.T." in *Live Stock Journal.*

Drying Off.—Some cows, especially " deep " or prolonged milkers, are often a source of trouble to their owners as regards the period of time during which a cow should be dry previous to calving. For such animals most cowkeepers consider six weeks a fair rest. In the case of poor milkers there is no difficulty. They go dry themselves all too soon for their owners, and some of them will take without leave as much as three months' rest, or may in response to persistent and generous feeding produce a small quantity of milk that scarcely pays for taking, let alone the feeding. Animals of this class should not be retained in the dairy herd, and if after one or two trials they fail to come up to the average of their breed, they should be consigned to the butcher. A cow in poor condition may be allowed two months in which to recruit her strength with advantage to both herself and calf, but this is generally a matter of keep, for the poor cow usually belongs to the poor feeder. Some cows when gestation becomes advanced produce a milk that is altered in quality or appearance, or unpleasant to taste. In these cases there is often no better course to pursue than to dry off. Where the cow is healthy and in good condition, and the quantity of milk yielded really profitable, there seems no reason why, with good feeding, the milking should not be continued until within a month of calving. Six weeks may, however, be considered the average period during which a cow should be dry.

How to dry a cow is a question on which there appears to be considerable difference of opinion. Much, no doubt, depends on circumstances and the class of cow we have to do with. There are many cases where it is desired to dry a cow while she is still producing a considerable quantity of milk. Take, for example, the case of a cow that is still giving two gallons of milk per diem sixteen months after calving. With cows whose milking qualities are of such lasting character there seems nothing to do but to " milk round," since drying, without running considerable risk of udder disease, is practically impossible. In normal cases I prefer the plan of milking

only once a day for several days, and then on alternate days as the supply falls off, but at each milking stripping the udder. Milk not required is not secreted. It is the persistent dragging at the teats, the patient asking for more twice every day, that, in connection with selection, has created the modern dairy cow. If the drying is effected gradually, by prolonging the intervals of milking, the secretion becomes gradually less without the risks associated with half milking, or, worse still, with not milking at all. Imperfect removal of the milk is a very ready way of drying a cow off when this result is not wanted, Nature assuming that the quantity produced is not required, speedily reduces the secretion. But it is also well understood that neglecting to strip the udder, besides resulting in the loss of the richest portion of the milk, is a very ready way of producing bad udders and "lost" quarters. In dairies where udder troubles are frequent, imperfect removal of the milk is generally at the bottom of it, and very often it needs a change of milker before the constant occurrence of bad udders can be stopped. Leaving the animal alone altogether so far as milking is concerned is a highly dangerous proceeding with a cow giving any quantity of milk, and is only practicable in the case of animals whose secretion is very small indeed, and who want very little inviting to cease the supply entirely. Allowing a cow to remain a long time without milking in order to secure a full and tempting bag at the time of sale has often resulted in acute inflammation of the udder. This neglecting to milk is called "overstocking," and is rightly regarded as cruelty. That the action of milking promotes the secretion of milk and retards the process of drying, there is no manner of doubt, but better this than subject the unfortunate animal to the pain of prolonged retention and the risk of permanent injury. When the gland is obviously distended, whether it is a cow being dried off or any animal whose offspring has been taken away, it should be at once relieved.

With regard to the employment of drugs in the process of drying off, there are drugs that act markedly on the milk secretion in the direction of drying it up, and they are less uncertain in their action than the agents which rank as galactagogues or increasers of milk; but to expect the drench to do everything, especially when, for convenience or economy, the cowkeeper wants to keep the cow at grass and dry her at the same time, is folly. The animal should be put on a dry diet, and one that is the reverse of rich in milk-producing constituents, and the quantity of this should be as small as is consistent with the proper nourishment of the cow and her prospective calf. Hay or oat straw, and a restricted supply of

these, will soon tell its tale, for although some cows will continue to produce milk at the expense of their bodies while others store it up in the shape of fat, the rule is that a dry, restricted diet is not favourable to a large milk secretion. There is a further advantage in the removal of the cow from succulent pasture to the kind of feeding recommended, since it is perhaps the most successful preventive of "milk-fever," especially if at the same time the bowels are kept relaxed; and as the heavy milker is also the milk-fever subject, it is good policy. Small doses of alum as an astringent, with reduction in the richness and succulence of the diet and the frequency of the milking, will generally dry off a cow without risk of danger to her health or spoiling her udder.- "VETERAN" in *Farm and Home.*

Frame Building.— There is at least one point to which the ordinary pig breeder does not appear to have given so much attention as is advisable, if not imperative, where complete success is desired.

It is the building up of the frames of the immature pigs which the sow is carrying. This want of attention, which might even be termed in some cases neglect, may arise from several causes—a not unusual one being absence of thought or knowledge of the enormous drain made on the sow in the building up of from fifteen to twenty frames during the short period of sixteen weeks. This heavy demand on the pregnant sow is easy of realisation when due consideration is given to the fact that the production of these pigs means the formation, weekly, by the sow of something like two pounds of skin, muscle, bone, and flesh, in addition to the natural calls of renewing her own frame, the provision of heat to keep the pot boiling, and of power for locomotion purposes.

Probably one of the chief causes of this want of observation or consideration is the absence in this country of those experiment stations and agricultural schools, which in America are general in each State.

These experiment stations are known all the world over for their splendid practical work in connection with the breeding and general management of stock. Efforts—and almost without exception successful efforts—have been made to discover the requirements of the various kinds of live stock and the means by which their wants are supplied in the most economical manner.

If the majority of so-called practical pig-keepers were asked as to the weight of young pigs when first farrowed, the replies would, as a rule, be merely a guess, and frequently the answer would be very wide of the mark. One of the most observant stock breeders whom I had the privilege of knowing and corresponding with, took considerable pains to discover the weight of newly-farrowed pigs, from young

and old sows, weighing from 240lbs. to 577lbs., previous to farrowing. These sows were principally Berkshires or Poland Chinas or crosses of these with other breeds. The number of pigs in each litter were few, as they averaged only a little over seven. Of these about six per cent. were farrowed dead, so that the average weight might from that cause have been slightly reduced. The live pigs varied in weight from 1·8lbs. to 3·1lbs. The average of all, live and dead, came out at about 2·5lbs. It is, of course, probable that the pigs of a sow farrowing fifteen pigs would not average quite as much as this, since the pigs might not be in quite so fat a condition ; but one may fairly estimate the average weight of pigs of a litter of fifteen at 2lbs. each ; where the sow is robust and has been properly fed during pregnancy, the average would frequently be higher.

The pregnant sow would also have another call on her—to gather flesh in order that she may have a reserve of strength or condition on which to draw during the period of lactation. It is almost impossible to prevent a sow worthy of the name losing flesh from the time she farrows until the pigs are at least six weeks old, unless the sow is so fed that the pigs suffer from diarrhœa and other infantile ailments.

A pamphlet has recently been issued from the Agricultural Experiment Station of the University of Wisconsin, giving details of experiments carried out to discover if any variation results from differing ways of feeding the pregnant sow. Briefly stated, the conclusions arrived at were that a sow so fed that during her pregnancy she was gaining flesh farrowed pigs of greater average weight than did a sow insufficiently fed. Further, that some kinds of food had a greater beneficial effect on the growth of the fœtus than others. These experiments also showed that an addition of some ten per cent. of alfalfa to the corn ration had the effect of increasing the average weight of the young pigs. Clover also had, to a more limited extent, the same effect.

It is also probable that the addition of lucerne or alfalfa to the ration of the milking sow may assist the growth of the sucking pigs. If so, the cause of thrift of young pigs when lucerne forms a portion of the sow's diet is made evident.

The chief lesson to be learned from the above by the breeder and feeder of pigs is that to obtain the best results the pig must be fed on exactly those kinds of food which furnish the particular nutriment needed for the purpose of growth and increase of flesh.

Nor would it be amiss to remind pig breeders that it is imperative to feed the pregnant sow liberally as well as properly if large litters of strong and healthy pigs are desired.—" St. Anthony " in *Live Stock Journal.*

The Value of Albuminoids.—Just as farmers have for some years appreciated the fact that although farmyard manure must be the basis of their manuring, better results are obtained if phosphates are used along with it, so they are now beginning to recognise that although hay, straw, and roots must form the basis of their feeding, better results are obtained when these farm foods are balanced with a certain quantity of extra albuminoids. It has long been known that young stock grew better, cows gave more milk, and bullocks fattened more quickly when certain cakes, such as linseed and cotton were given in moderate quantity along with the bulky farm foods; but only comparatively recently has it been understood that the main value of these cakes lay in the amount of digestible albuminoids they supplied to the stock. Up to a few years ago it was thought that the feeding value of the cake lay in the oil, and farmers were prepared to give much higher prices for cakes containing large percentages of oil, but many exact trials and a good deal of practical experience have shown that, except in the case of quite young calves and lambs, the oil has little more value in a properly balanced ration than two and a half times the same weight of starch or sugar.

It is, and always has been, the extra albuminoids that were required, and that this is so is easy to see if a few practical experiences are taken into consideration. A calf when off milk at three or four months old will do badly on hay alone or on hay and a few pulped roots, but if 1lb. of linseed cake per day is given in addition it will do well. The linseed cake will contain about 28 per cent. of albuminoids, 30 per cent. of carbohydrates, and 8 per cent. of oil. The hay and roots—say 4lbs. of hay and 6lbs. of roots—will supply it with about ¼lb. of digestible albuminoids, 1¼lb. of carbohydrates, and ¾oz. of fat. The linseed cake added to this supplies another ¼lb. of digestible albuminoids, thus doubling the albuminoids, and ¼lb. to the carbohydrates, while it only adds 1¼oz. to the fat. It is evidently not the addition of ¼lb. of carbohydrates to the 1¼lb. already present that makes the difference, nor is 1¼oz. of fat likely to make the difference between doing badly and doing well, when we consider that a gallon of milk contains 5½ozs. of fat. The fact of the matter is that the calf requires flesh-forming material to be able to grow, and the additional ¼lb. of albuminoids just balances the ration and enables it to put on flesh. It is also a common experience that bullocks will not fatten, in England at any rate, on roots and oat straw, even though they get 1½ to 2 bushels of roots a day and as much straw as they care to eat. If, however, 7lbs. or 8lbs. of Egyptian cotton cake is added they should be

fit for the butcher in 100 to 120 days. The straw and roots would supply each animal with rather less than 1lb. of digestible albuminoids, about 13lbs. of carbohydrates, and ¼lb. of fat; but the cake would add nearly 1½lb. of albuminoids, about the same quantity of carbohydrates, and about 6ozs. of fats. It is evidently neither the carbohydrates nor the fat that has made much difference to the ration, and yet the difference in the way the animals do is most marked.

Many more well known and practical instances could be given of the same kind especially with dairy cows, but the two given are sufficient to show the practical importance of albuminoids in feeding. There are two or three reasons for this importance that are worth mentioning. The first is that the substances included under the name of albuminoids in an analysis are the only ones in the food that contain nitrogen, and for that reason are the only substances in the food that can be used by the animal in growing new muscles and other tissues containing nitrogen and in repairing the wastage constantly taking place in the nitrogenous tissues it already has. The blood, muscles, bones, skin, hair, hoofs, and horns all contain albuminoids, and therefore nitrogen, and have to be constantly kept in a state of growth and repair. The demand for this nitrogenous material from the food is considerable, and the more rapidly the animal is growing and the bigger it is the more albuminoids it requires. Less is naturally required when the animal has done growing, as it has few new tissues to make, beyond its hair and hoofs, but a good deal is still wanted for repairs, particularly if it leads an active life like a working horse, or is breeding or milking. Neither the carbohydrates nor the fats of the food contain any nitrogen, and therefore cannot be used to supply or repair the nitrogenous substances of the body, though they are most important in supplying heat and energy, and may be built in amongst the nitrogenous material if the framework, so to speak, is there to receive them.

The next most important reason why additional albuminoids are so often required in stock feeding is that the greater number of our ordinary farm foods do not contain a sufficiently large proportion of albuminoids for the requirements, particularly in winter, of the kind of stock we keep and feed. The best of all farm foods, as every farmer knows, is green pasture grass grazed in May and June. It is not only the natural food of horses, cattle, and sheep, but it is found on analysis that it contains in the early part of the summer about one part of albuminoids to each 4½ or 5 parts of carbohydrates and oil, so that for each 1lb. of albuminoids the animal

digests it also digests 4½lbs. to 5lbs. of the carbohydrates and fats. The actual fat or oil in grass is, however, exceedingly small, being less than one-third of the quantity of albuminoids. There is, however, this peculiarity about grass : the proportion of albuminoids in it decreases considerably as the season advances, so that in autumn there may be as much as six or seven parts of carbohydrates to each part of albuminods. It is in spring in a state of nature that young animals are born, and the high proportion of albuminoids is exactly suited to their needs and to the needs of the mothers for the production of milk. In autumn fat is stored up against the coming winter and the proportion of carbohydrates is increased.

It has been found by many trials and by the results of practical experience that the proportions provided by Nature in the grass are almost exactly those at which the farmer should aim in the winter rations he uses for his stock. His farm foodstuffs do not, however, always lend themselves to obtaining the correct proportions. Even hay, which should be simply dried grass, does not contain sufficient albuminoids for the younger stock or for dairy cows, because it is cut in July as a rule, and contains a large proportion of stalks or bents, which the grazed grass does not. Good pasture hay contains on the average about 1 part of digestible albuminoids to 6 or 6½ parts of carbohydrates, though clover hay or hay containing a large proportion of clover may give a proportion of 1 to 5 or 5½. Straw, even good oat straw, contains very little digestible albuminoids, only about 1 per cent. to 40 per cent. of carbohydrates. Roots of all kinds run about one of albuminoids to 10 of carbohydrates, so that it is easy to see how a mixture of straw and roots would fall far below the natural requirements of any kind of stock, and how essential it is to add albuminoids if the stock are to thrive. Pea and bean straw contain more albuminoids than the cereal straws, though the bean straw is somewhat indigestible. Clovers are all fairly rich in albuminoids, but grasses of all kinds contain considerably less.

All the cereal grains are poor in albuminoids. The proportions of digestible albuminoids to carbohydrates and oil are in wheat about 1 to 7, in oats 1 to 6, in barley 1 to 8, or 9, and in maize 1 to 10. Beans and peas are rich in albuminoids, the proportion in beans being 1 to 2½, and in peas about 1 to 3. These are the richest of the farm-grown foods, and it will be apparent why foods like cotton cake, soya cake, and earthnut cake are so useful for mixing with straw and roots when we consider that they contain as much or even more albuminoids than they do of carbohydrates and oil. The higher the percentage of albuminoids in the cake, the less it will

take to bring up the albuminoids in any given quantity of straw and roots. The best proportions of albuminoids to carbohydrates in any ration varies with the class of stock, but, as has been stated, the best proportions for calves and dairy cows are about 1 to 4½ or 1 to 5, though as the calves grow the proportions may be widened to as much as 1 to 6½ or 7 for a two or two and a half year old store. For fattening, 1 to 6½ will do well at the beginning, decreasing to 1 to 6 towards the end, which means adding more cake as is found in practice to be the correct thing. This proportioning of the constituents of the food is most important, for an animal can no more build up its body without the correct materials than a man can build a brick wall without mortar. Further, if the proportions are incorrect, the surplus of that in excess is largely wasted and money is lost. It is generally the albuminoids that are deficient, owing to the composition of our farm foods, and for that reason they are of extreme importance to the farmer.—*Agricultural Gazette.*

Keep the Tools Sharp.—One way of securing ease and efficiency in farm work is to keep the tools sharp. On many farms there is an enormous waste of strength.

The men and boys use dull hoes in working among the crops, cut the grass with dull scythes, cut wood with dull saws and axes, and do various other kinds of work with tools which are in poor condition for service. Women cut bread and meat with dull knives, and pare potatoes and apples and do other kinds of work for which an implement with a keen edge is needed with knives from which the edge has long since departed. Horses are often required to draw mowing machines and reapers of which the knives are dull. The machines are subjected to a greatly increased strain, which causes them to wear out much sooner than they ought to; the work is poorly done; the draught is much heavier than it should be, and much of the strength of the team is wasted. The man or woman who attempts to do work with dull tools is wasting strength, and strength being one of the most costly things on the farm, in the house, or anywhere else, it ought to be economised with the greatest care. Force once exerted, whether it accomplishes much or produces no effect, is gone for ever. Therefore it should be directed wisely and made as efficient as possible.

A man mowing with a dull scythe cannot cut nearly so much grass in a given time as he could with a sharp one, and he has to work a great deal harder than he would if his scythe was sharp. In hoeing, and every other kind of work in which sharp tools are needed, labour cannot be efficient if the tools are dull. Work as hard as he may,

the man who works with tools that are dull cannot work efficiently. The practical application of this subject is important at all times. The hoes, scythes, and mowing-machine knives should be kept constantly sharp. Use the file and grindstone freely and often. They will wear the implement to some extent, but they will enable the worker to do more and better work, and will prevent a needless expenditure of strength. It is better to wear away steel than to wear away the human frame or waste the work of teams.. One of the things which every boy on a farm should be taught is that tools should always be kept in perfect order. He should also be shown how this can be done. By the time he is eighteen years old he should be able to put a keen edge on scythes, knives, shears, and all similar tools; to whet as well as grind a scythe, and to keep all edged tools which are needed on the farm or in the house in perfect condition for use. So, too, all ploughs, cultivators, harrows, and similar farm implements should be kept constantly sharp. It is one of the poorest kinds of so-called economy to wear the plough-point to the utmost possible limit before getting a new one, or to use the harrow teeth until the points are entirely worn off before having them sharpened. When buying tools great care should be taken to get good ones, and it is of equal importance to keep these tools in the most perfect order possible. Only in this way can they be made to render all the service of which they are capable, and enable the worker to utilise his strength, or the strength of his teams, to the best advantage.—"T." in *Farm and Home.*

The Farmhouse in Relation to Food Supply and Labour Problems. —Mrs. Blair, who was described by the Chairman, as "a farmer's wife, and also the daughter of a farmer," in a lecture to the Glasgow and West of Scotland Agricultural Discussion Society, said:—The question of food supply and the labour problem are being exhaustively dealt with from the point of view of the agriculturist. It was with the view of treating them from the domestic aspect that I accepted your invitation here to-day.

When we come to consider the farmhouse itself in its relation to food supply and labour, we are met at the outset with the difficulty of defining the farmhouse. To one mind it suggests a palatial abode. The lady of the house has only a nominal interest in the food supply, and the labour problem is present only in the shape of domestic servants. Consumption far exceeds the production of food so far as the household is concerned. This we may term the farmhouse of the leisured.

To another mind the farmhouse is seen in close proximity to the

farm buildings, and more or less directly connected with the dairy, an indifferent garden, an atmosphere of bustle, the women of the household contributing materially to the food supply by unremitting toil amidst milk and eggs and poultry. The labour problem is here very acute, too often resulting in a life of drudgery for the women of the house.

Between those two types there are, of course, many grades, but of whatsoever type, they have, one and all, to rely almost exclusively upon the houses on the farm, or in the rural areas, for their supply of labour. On one occasion, some years ago, I interviewed a girl in town, with the idea of engaging her as a house-servant. When I explained where we lived, she said, in an astonished tone—" Go to the country ! I'm leaving here tae better ma' sel'." That is typical of the general attitude towards country service. Therefore, it is to the direct interest of the farmhouse to get labour back to the land.

On the 29th of August a large and representative body of agriculturists met in Glasgow to deal with the future of agriculture. One speaker went to the root of the matter when he said that " the great evil with which they had to contend was the drift of labour from the rural areas." If the future of agriculture depends upon getting labour back to the land then the supply of labour is equally dependent upon good housing and better social conditions. The questions of housing and social conditions are essentially questions with which women should deal. She who wears the shoe knows best where it pinches, so the woman who best knows the limitations of these housing and social conditions is best able to speak of them. I therefore submit that when dealing with the " conditions governing the future of agriculture " the co-operation of women should be invited. But to be able to co-operate successfully we must be sure that our aim is identical. Are we aiming at greater wealth for the farmer and landowner, or for a higher standard of the common life ? Are we desirous of personal gain, or the greatest good of the greatest number ? Do we want privilege for the few, or justice for the many ? Our soldiers have gone forth voluntarily offering their best —their all—in defence of the homeland. It is up to each one of us, then, to do his or her best to make the homeland worthy of their sacrifice. If we do less than our best we fail our boys—we are only worthy to be ranked as shirkers, just as much as if we had deserted them in the trenches.

What does " Back to the Land " mean ? Those who talk so glibly of settling ex-soldiers and sailors on the land, of getting labour back to the land, very often overlook the significance of the word " back." Let us take it for granted that the ex-soldiers and

labourers are for the most part married men. Do you think that the woman, who, even as a girl has experienced the inconvenience and discomfort of a country cottage life, will readily return to these after enjoying the comparative comforts of town life? And the men won't go without their wives! It is well to bear in mind that the labourer in his choice of a calling is not influenced solely by the amount of his pay and the nature of his work, but also by the nature of his home.

I do not think town life compares favourably with a country life --far from it. The farmer's wife who lives within a reasonable distance of town, and enjoys a modicum of leisure, has an ideal life. But the woman who has to drudge inside the house whether in town or country, naturally compares the relative merits of the houses, the advantage of a dry wooden floor over a damp flagged one, the convenience of turning on a tap in lieu of carrying water from a well, the pleasure of nipping round the corner for a kipper for tea compared to the wearisome trudge on a Saturday night after 6 o'clock for the weekly shopping! Vicountess Wolseley, who writes largely about getting women on the land, holds out the "beauty of the changing seasons" as an attraction, which is all very well for those who have the means to enjoy these beauties. But to the woman whose horizon is represented by the four walls of her house, the changing seasons suggest little besides a stuffy kitchen in summer, a frozen rain barrel in winter, bronchitis in the spring, and wet clothes in autumn. If it is desirable to have labour back to the land, it is obvious that the housing conditions must be rendered more attractive and more convenient.

Rural housing always suggests to me a village dressmaker whom I know. Sewing so much seems to give her time to think. Her power of descriptive expression fills me with envy. I have often tried to get her to write or speak in public as she speaks to me, but she replies, "Na, na; ye need tae ha'e the hide o' an elephant to speak in public." One day she was on housing. "Sic like hooses! Built ablow the level o' the ground. Can ye wonder that they are damp. On the Sabbath mornin' ye tak' yer boots oot ablow the bed; they're like a pair o' white rabbits wi' mould. No a press ava'! A' thae dishes jist catchin' the dirt! Shelves where a body canna rax tae them. Men shouldna build hooses. Men hà'e nae heids." Then she added in justice, "Oh, weel, they have heids, ye ken, but so has preens."

Whatever the houses are like, if the people want to remain in the district they have just to keep a "calm sough," otherwise the sanitary inspector may condemn them, there are no other houses to be

got, and there is no power in this country, as yet, to compel landlords to erect decent dwellings on the land from which they draw the rents.

Mr. Christopher Turnor, speaking in Glasgow on the 12th September, told of a pleasing picture often to be seen in Sweden. The women, having finished their morning's work, worked on the land for an hour or two. In the afternoon, when their work was finished, they were to be seen seated in their verandahs, neatly dressed, busy with embroidery. Their houses, he said, were "altogether delightful." Compare this with the conditions prevailing in many of our rural areas.

Amongst other things, how absurd it is to have houses all one size to accommodate families of various sizes. Needless to say, no great scheme of reconstruction can be carried through at present; but I submit that a practical scheme should be discussed and legislation passed which will release the million men in the building trade—or what is left of them—immediately demobilisation takes place, to engage in the erection of dwelling-houses and hostels (suitable for labourers and ex-soldiers), to the exclusion of the erection of villas, golf club-houses, church halls, etc., until the requisite number of houses be completed. I further submit, that neither cottages nor houses for small holders should be erected without the plans being submitted to a practical woman with a knowledge of domestic requirements; and that, for this purpose, women should be represented on the Board of Agriculture and all housing commissions.

With regard to emergency labour and the need for providing adequate housing accommodation for those women who are brought to the farms, at present there should be a clean, fresh cottage prepared for them, containing a bed for each woman; furnishing sufficient to enable them to live in comfort; and arrangements made whereby someone will prepare their food for them. Only by so doing can a proper standard of efficiency be maintained. The lack of sanitary conveniences is the greatest drawback, and while it is impossible to put in individual baths and wash-houses, etc., under existing circumstances, a communal bath and wash-house might be considered. In the case of educated women being asked to go on a farm to train for agricultural service, accommodation should be found for them, wherever possible, in the farmhouse.

Side by side with bad housing in contributing to the drift of labour from the country are the existing social conditions. It is frequently urged that the lure of the town accounts for much. But the town has no power to attract the farmer from off the land. It is not so much the life of the town which draws as the dullness of the country which drives them away. Here again let me quote one who has felt

it. I knew that the mother of a large family had gone off unexpectedly for the week-end, and I asked how she had enjoyed herself. She said—" I just took a sudden thocht and gaed awa'. I hinna been like masel' for a while back. I was that crabbit. I was aye flightin' on the weans when they didna need it." Then the tears came into her eyes, and she said—" Men kens naethin' aboot it. They dinna understand. They are aye meetin' their neebors in the stable, and passin' the time o' day wi' the maister, or they're up at the station speaking tae somebody; but for the like o' me there's never a body to speak tae. Men dinna understan'." There you have the case in a nutshell. Women are denied the pleasure of working in common. Men do not understand the craving for social intercourse, the nervous depression resultant from all work and no play. It is that dullness which must be combated.

There is no more effective way of doing so than by the formation of women's clubs or women's institutes in the rural villages. These have been established for some time in Canada and the States, and copied by Belgium; and, since the war broke out, there have been some formed, with very good results, in England and Wales. They are composed of all classes of women, are partly recreational and partly educational. They have for their motto, " For Home and Country," and aim at the betterment of the home through the study of domestic economics, child welfare, &c. By social intercourse they are enabled to consider local needs, to encourage social industries and promote the increase of food production; thus linking up home with community life. The exchange of ideas, with respect to recipes and crochet patterns; lectures on hygiene, public health, war savings, bee-keeping, pig-rearing, poultry, and gardening; demonstrations in fruit bottling, in labour-saving appliances, and cookery, will provide a programme varied enough to interest all the members. Each member is expected to contribute her share in one way or another.

At a time such as this, special attention should be devoted to the means of increasing garden and poultry produce, and to the necessity for practising the most rigid economy. Much might be done to increase the number of eggs produced in this country by recognising the importance of securing a good laying strain as well as a good breed of fowl. In the case of the table bird, the quantity rather than the colour of the flesh should be the chief consideration. The intensive system is, I believe, well suited to village poultry runs. Poultry clubs have already been started in England, and the members of the institute are being encouraged to buy chicken food and to market their produce co-operatively. In the case of garden produce,

farmhouse gardens could generally be cultivated to greater advantage not only by growing a more abundant supply of fruit and vegetables, but by using a greater variety, and by conserving fruit and vegetables in their season and thus securing a varied and plentiful supply all the year round. When a garden is larger than necessary for the needs of a household, there are depots to which one can send fruit and vegetables, where they are packed and dispatched to the fleet. The value of vegetable food is only now beginning to be realised, when meat is beyond the purse of many people. I should also like to advocate the use of margarine, the food value of which is equal to the best butter, while the cost is about half.

The economic importance of conserving food by means of sterilising is not yet generally enough recognised in farmhouses, yet it is desirable, not only on account of the value of the food, but also for the convenience of having a store of soup, meat, fruit, and vegetables always at hand. The process is simple, and though the initial cost of the outfit is considerable, it is soon made good, after which it leaves clear profit. Each institute could buy the most efficient plant, and hire it out to members. These institutes appear to me to be the only feasible and practical means of establishing a better social order; and they have the additional advantage of adding a stimulus to agricultural interests. There never was a time more propitious for their formation than now, when women are already drawn together with a common aim and a common sorrow. In England the Agricultural Organisation Society has helped to form branches by sending speakers, by giving literature and expert advice; and the sister society in Scotland will, no doubt, do likewise. If, through recruiting, their staff is depleted, they could with advantage avail themselves of the organising genius of women.

There is just one point more I should like to emphasise with regard to these institutes. Women must be free to join them. Nay, more, farmers' wives especially must realise that to take part in the life of the community, to contribute their share in the brightening and usefulness of that common life, is a sacred duty. The day is past for women to defer to men in matters of this kind. Men must accord to women the moral right to think and act for themselves. We are told that " woman's place is the home " ; so it is, but it is a man's place also. Just as his business necessitates his frequent absence from home, so to keep up to date in her business also necessitates woman's occasional absence.

The problem of domestic labour in the farmhouse is a very difficult one, and where there is a dairy the lack of milkers is a serious consideration. In the case of those farms where the early-rising milk

trade is carried on—where young folks or married women are routed out of bed in the small hours of the morning to milk—we hope the scarcity of labour will increase, until it forces a more humane system to be established. Parliament interfered with the labour of flower-girls; it also regulates the hours that women shall work in factories; but in these dairy farms the women continue to drudge under contions which are physically harmful and mentally depressing. Is it to be wondered at that the scarcity of milkers in East Lothian has resulted in some cases in farmers selling their cows and obtaining milk from the nearest dairy. In certain villages the people walk two miles for milk. The Anzac wasn't far wrong when he twitted the Britisher about "our old back number of a country."

As regards education. The education authorities and the Board of Agriculture might co-operate to establish a second-grade school, with several acres of land attached, where boys and girls of fourteen or upwards might continue their higher-grade education. They should be grounded in the elementary theory and practice of agriculture and domestic science, while at the same time continuing their general education; and in rural areas these schools would need to be the invariable rule. They would link up the elementary school and the technical colleges. Along with that arrangement, and quite as necessary, if not more so, is a thorough re-arrangement of our present system of elementary education. Children at present are instructed in all sorts of useless information, fed with facts, instead of being allowed to grow and develop mentally by their own efforts and with their teacher's guidance. They are disciplined, taught obedience, their individuality crushed. If a farmer sows wheat too close, the head becomes stunted. No amount of after treatment will undo the evil that want of freedom in its early stages has wrought. So it is in the case of education. For want of freedom to grow, to assimilate the knowledge poured into it, the child loses vitality of intellect; and consequently, when technical knowledge is later put within his reach, he has partly lost the power to grasp it. Special attention should be directed to farm domestic science; and I submit that domestic science should be accorded its rightful place in the educational world and entitle to a B.Sc. degree equal to that granted in agriculture. To manage a farmhouse efficiently, with all the duties contingent, requires a mental ability and a versatility as great, or perhaps greater, than to manage a farm.

The Governors of the West of Scotland College of Agriculture have made arrangements whereby women desirous of learning to milk or to learn farm work can receive a course of training (three weeks or longer), with free board and lodging, at the college farm

at Kilmarnock, which is a step in the right direction, but it merely touches the fringe of the problem.

Whether it be dairy or domestic help that is wanted, it is generally difficult to obtain. We speak of the incompetence of the girls, the almost feverish unrest and desire for outings, the lack of interest in their work, the resentment of authority. These cause constant irritation and frequent friction. It could not be otherwise. As civilisation advances we become fastidious. The more intelligent of the girls amongst the labour class refuse to undertake domestic service. Can we blame them? Housework, cooking, dairy and poultry work, are not irksome in themselves. They are, on the contrary, most interesting. It is the conditions attached to service which militate against it.

We must have an increase of justice towards women as domestic workers. Housekeeping, cooking, and dairy work is skilled labour, and should be paid for as such. Domestic workers should be regarded as employees, just as though they were in a factory. We are wont to say they have many advantages over a factory-girl or an out-worker because they have a good home. But they are not really in our home. They live in a part of it—the less beautiful and less comfortable part of it. We take them from their homes and their own social life. They have no real freedom—only the few hours we allow them. Their work may not be arduous, but their hours are long and duties often undefined. The only solution seems to be to have fixed daily labour, doing away, whenever possible, with the living-in system. A hostel would need to be erected on each farm, the size regulated by the number of women to be housed, both outdoor and indoor workers. A large airy living room, with a scullery fitted with bath, and general washing arrangements attached, a cubicle for each woman, and a parlour which could be had for the evening by arrangement. An elderly woman could act as matron. She would be paid by the girls, and could augment that pay by odd work in her spare time. The girls would engage to work for so many hours per day—extra pay for overtime. The benefit of such an arrangement would be mutual—the mistress or employer would be freed from much worry, have fewer bedrooms to keep, less washing to do, but above all, there would be the greater freedom and different atmosphere of the home. With a human background to their lives, definite hours of work, extra pay for overtime, good wages for skilled labour, I see no reason why the labour of the house should not be got through with pleasure on both sides. One has to consider that after the war there will undoubtedly be many women unmated who will have to live a bachelor life.

The labour of the house to-day can be immensely lightened by the aid of scientific appliances; and these appliances are perhaps more beneficial in the farmhouse than in any other, because the dirt we have to contend with is mostly on the floor. Vacuum cleaners, sweeper vacs, oily mops and ronuk polishers do away with the old-time switching of carpets and turning out of rooms. Scullery and kitchen and dairy can be washed and scrubbed without going on the knees; clothes can be washed by the torpedo or vacuum washer without the rubbing. Barless grates and anthracite stoves give heat with little labour. Nowadays we really can keep our house clean to live in, and not live in it to keep it clean.

By stripping the house of all lumber, by retaining nothing which is not useful or beautiful, by adopting scientific appliances, the housework can be reduced to an astonishing degree, while the home gains rather than loses in elegance, and a wonderful amount of leisure can thus be secured for the important work of reading and thinking. There are farmers who scoff at these labour-saving appliances as "new-fangled ideas," and there are women who still say, "What was good enough for my mother is good enough for me." But have you ever heard a farmer say his grandfather cut his corn with a scythe and that was an argument against his using a binder to-day?

We must work. We must resolutely set aside prejudice, conventionality, and precedent, and by individual effort, by clear thinking, by fearless speaking, by unflagging industry and ceaseless economy, do our bit to

"Keep the home fires burning
Till the boys come home."

—*The Scottish Farmer.*

Marquis Wheat.—The great interest aroused in Marquis wheat over the whole of Western America during the past three or four years led the United States Department of Agriculture to order an investigation of its merits and demerits. The result is a report by the Bureau of Plant Industry. This first of all points out that the variety is a hybrid wheat produced by Drs. A. P. and C. E. Saunders, of the Central Experimental Farm, Ottawa. It is one of the descendants of a cross made in or about 1892. The female parent was a wheat from India, called Hard Red Calcutta; while the male parent was the widely-grown Red Fife wheat of Canada. The different forms resulting from this cross were separated in 1903 at

Ottawa, and each was grown by itself in 1904. One of these selections, being found to have desirable plant characters, was named Marquis at some time between 1905 and 1907.

The good milling qualities of Marquis wheat became apparent in 1906, and the variety was sent out to Manitoba for testing in 1907. In that year rust was very bad in the wheat-growing prairie provinces, and it was seen that the earliness of Marquis wheat enabled it to escape the rust. It soon became a leading variety in Manitoba and Saskatchewan. The yields of Marquis wheat at agricultural experiment stations in these provinces were 13·5 to 38 per cent. higher than the yields of Red Fife during the eight years 1907 to 1914 inclusive.

The variety was introduced into the United States on a fairly large scale in 1913. In 1914 the seed imported from Canada, added to the seed grown in 1913, enabled about half a million acres to be sown, and this produced a crop of some seven million bushels. This has supplied the seed for the United States since. very little having been imported after that for the 1914 crop. Experiments were carried out with the wheat in thirteen States—these ranging from Iowa and Minnesota on the east to Oregon and California in the west. In this long stretch of territory " the adaptation and value of Marquis wheat varied with local conditions," but the conclusions arrived at can be very briefly put as a whole. In the country west of the Mississippi River (sub-humid), Marquis wheat " slightly outyields " the ordinary varieties of spring wheats, but winter wheat, where it can be grown, outyields any spring wheat, and winter wheat should be grown in this section wherever it can be grown. In the semi-arid section (northern half of the Great Plain) spring wheat only is grown generally, and " Marquis has proved as good a yielder as any of the spring varieties grown." In the few districts where it can be grown, however, " winter wheat is decidedly better than any spring wheat," and Marquis is not recommended as a substitute. So far as other districts are concerned " Marquis wheat is not recommended for any district west of the Rocky Mountains." Summed up, the variety is only recommended for South Dakota and Central and Western North Dakota, where winter wheat cannot be grown anywhere, and even here it is thought that Durum wheat might be given the preference. Here " Marquis is better than any other variety of the spring common wheats in some parts, and about as good as any in all parts of this section. Where spring wheat is grown and Durum wheat is not used the Marquis is a safe variety to grow." The general advice given is to grow winter wheats wherever winter wheats can be grown. Where

spring wheats are grown, Marquis is well worth testing against the sorts usually cultivated.

The milling tests carried out by the United States show that, for flour-making, Marquis "is equal to or slightly superior to" Fife wheats.—*Agricultural Gazette.*

Mortality among Chickens.—Of the chickens brought into the world every year large numbers do not survive. Many die within the first few days, whilst others live to various ages from a week or two up to six weeks and then die off. All chickens are, as a rule, hatched healthy and strong, especially when they are able to live long enough to become fully developed in the shell and to peck their own way out. The fact of a chicken dying after being hatched arises from mismanagement in some form or other.

Food alien to their early growth given in order to stimulate their appetites is a mistake. They should be fed simply on rational diets such as crumbs of stale bread made palatable by being mixed with raw egg, or oatmeal in a prepared form.

Many chickens get bound up in their early stages. This usually arises from want of green food, regular supplies of chopped grass, or freedom to forage. Frequently it is from inattention to cleanliness and regularity in diet. Sour food—that is food prepared before required, and allowed to ferment—is a frequent cause of diarrhœa. Oatmeal is especially troublesome in this respect, and must always be given fresh.

Overcrowding in small pens or boxes stunts their growth and too often causes them to contract ailments. When crowded into foster mothers, even if these are well ventilated, chicks grow slowly and lack vigour. Such receptacles are intended for shelter, not for lodgment day and night. A foster mother should be to the chickens what the mother hen is.

Chickens of all ages are often allowed to run together, feed together, and shelter together. This is always fatal; they fight and struggle for food, with the result that the weakest go to the wall. Limited runs are too often the cause of this. Healthy chickens are allowed freedom to forage and natural associations. Epidemic diseases among chickens generally arise from stale water, polluted drinking-vessels, or want of sanitation in the coops or foster mothers.

Growing chickens, in order to develop after their early stages are passed, must have frame-forming foods, more especially when they have only a limited run. When they have woodlands or grass ranges to forage over, they can select insects, grubs, and seeds, according to their natural tastes and instinct. Their food has to supplement such

natural diets. Chicks reared in pens fed on indifferent and injudicious foods without studying their natural appetites, waste, and eventually die.

Some chickens take on feathers more rapidly and regularly than others. Cold weather retards growth and leads to colds in the coop and pen. Cockerels are generally less scantily fed than the female chickens. Some breeds, as Brahmas, and, in fact, all Asiatic strains, feather very slowly. It should, however, be remembered that slow feathering is not always a symptom or indication of weak constitution. Inbred strains show this peculiarity: but Brahmas, a very hardy breed, always take on feathers slowly. Food here plays an important part. It must be of a mineral nature, containing bone-forming constituents. Starchy foods are detrimental; green foods, crushed oats, sharps, and animal food (not fatty) are valuable. Sulphur is a powerful stimulant, and is present in all green foods. It forms a nourishing part to feathers, and a small quantity of flowers of sulphur occasionally dusted over the morning soft diet has a marked benefit on the production of feathers. Sulphate of iron in the drinking water acts as a constitutional tonic. Earthenware or iron drinking vessels should be used, never tin or zinc basins. Milk is nourishing and fattening, and may with profit be given in the drinking vessels or mixed with their soft diets daily. —" S. W." in *The Scottish Farmer.*

Udder Troubles in Sheep.—Exposure to cold and wet, moisture and filth in the places where the animals have to lie down, hardness and dryness of the pasture or fold, bruising from the vigorous use of the lamb's head in its efforts to obtain milk, failure to pay proper attention to the udder when weaning the lamb of the previous season, removal, or the loss of one of twins so that the survivor has become accustomed to suck one side only, when milk accumulates in the undrawn section, and soreness of the teats, giving rise to refusal to permit the lamb to suck, and the consequent retention of the milk, are among the most common causes of "bad" udders in sheep. Yet this list does not by any means exhaust them. Sore teats are both a cause and a result of bad udders. As mammary inflammation is most frequent and also most troublesome and destructive in bad weather, we must put down exposure to wet and cold as the most fertile cause. The weather, which is often uncertain at the season of lambing, cannot be controlled, but the effects of wet and cold may, to some extent at least, be mitigated by greater care in trimming up before lambing. The absence of the tail, and the practice of closely clipping the wool from the neighbourhood of the

udder and genitals, as a routine sanitary measure or to give the lamb free access to the teat without sucking in fibres and falling a victim to " wool-ball," are undoubtedly causes of inflammation in unfavourable seasons. There are many points in favour of judicious " under locking," but it should always be practised in moderation, and with due regard to situation and season. It is claimed for the Dorset Horns, ewes which are in full milk during the winter, that their immunity from udder troubles is due to their having long tails. Ewes are drafted from big flocks for many reasons besides being aged or " broken-mouthed," and very often the buyer of draft ewes or " culls " buys trouble. Imperfection of the udder, the result of previous disease, is a common cause of loss among this class of sheep. Ewes ought to be watched when the lambs are taken off them, and any case of distress from accumulation of milk relieved. Every year, as surely as lambing time comes round, there is the difficulty of ewes with sore teats to contend with. In some seasons the trouble seems more general than in others, but it is common to have some ewes that refuse to let their lambs suck, and these get swelled, hard, and inflamed udders through the milk not being drawn off.

Sores on the teats are, in the first instance, generally attributed to the lambs biting or scratching the teats when sucking. Two very opposite conditions may cause them to do this—when the udder is too full, or when the supply of milk is limited. In the first-named case the udder is said to be " wedged " or " caked," and to cause the lamb to drag viciously at the teat, just as if the milk supply was short or the udder empty. Probably the more fertile cause is the exposure to cold winds after the lamb has been sucking, which will result in chaps and cracks, but in either case the teats become inflamed and scabbed over, increasing the difficulty of the lambs obtaining milk, and causing the ewe such acute pain that she is reluctant to let the animal suck or may refuse to permit it to do so at all. If no notice is paid to sore teats the trouble is very soon increased by the establishment of garget. Attention is usually first drawn to something wrong with the udder by the thin appearance of the lamb or lambs, and the refusal or evident disinclination of the ewe to let her offspring suck, or by her walking with her hind legs wide apart to relieve the tender, swollen mammæ from the pressure of the thighs. By this time the inflammation will probably have made some progress, and the udder will be found hot, swollen, and tender. The constitutional disturbance varies with the severity of the case, but there is generally more or less fever. The course of the disease and its terminations are much the same as those met

with in the cow, but a peculiar feature of the inflammation of the udder in the ewe is the greater frequency with which it takes on the gangrenous form, and ends in sloughing out of the section of the gland attacked. Gangrene or mortification means death of the part, but does not always result in the death of the ewe. Such cases, however, do frequently terminate fatally, especially when neglected, and when they do not the animal generally falls away in condition, and takes so long to recover that it would in many cases have been less expensive had it died. The reason why gangrene is so common a termination is probably because it is often far advanced before its existence is discovered.

Prompt attention should always be paid to cracked or sore teats. If the udder is too full, or inclined to be hard, it should be relieved by hand, or the ewe held while the lamb sucks. The scabbed teats must have been previously anointed with a little elderflower ointment or lanolin. This softens and lessens the pain caused by the sucking. In bad cases it may be necessary to remove the lamb and dry the ewe, adopting treatment suited to mammary inflammation. After the lamb has sucked, or in bad cases where it does not suck at all, an ointment made by mixing 80 grains of oxide of zinc with 1 oz. of lanolin is a good dressing for sore teats. A useful ointment with which the shepherd may be supplied for rubbing hard udders is :—Powdered camphor, 2 drachms; mercurial ointment, 1 drachm; marsh mallow ointment, 2 oz. . Simple camphor liniment, or "camphorated oil," as it is popularly called, made by dissolving 1 oz. of finely broken camphor in 4 oz. of pure olive oil, is also a useful stock dressing for bad udders, or for use after fomentation. When a ewe is seen to be straddling in her gait, restless, refusing her lamb, or giving other evidence of pain or discomfort, she should be caught and examined. If found swollen and painful the udder should be well fomented with hot water, the milk removed either by hand or by holding the ewe while the lamb sucks, and the gland rubbed or worked about, with the camphor ointment or liniment as a lubricant. In severe cases the ewe should be removed to sheltered quarters, since exposure to cold aggravates the trouble. It is of no use dabbling about with a little lukewarm water once a day, the gland should be properly fomented with hot water three or four times a day, and afterwards well worked about, and everything possible got from the teat. The lamb must, of course, be provided for in some way, and the necessity for this is one of the troublesome annoyances of several cases of inflammation of the udder in a flock. If fever runs high constitutional treatment becomes necessary. A saline purge, in the shape of a full dose of Epsom salts, and nitrate

of potash should be given in ale or gruel, followed by ½ to 1 drachm dose of bicarbonate of potash in solution.

When the pain is very great relief may be given by rubbing the gland with belladonna ointment, or a lotion containing extract of belladonna dissolved in hot water may be used as a dressing. When induration results there is not much to be done. The gland retains its stony hardness, and efforts at reducing it do not pay. Should suppuration threaten, fomentation or poulticing should be kept up, and as soon as pus has formed abscesses should be opened, and the cavity syringed out frequently with a solution of chinosol or other antiseptic lotion. When gangrene occurs, amputation would be best, because quickest, but this, of course, is the business of the veterinary surgeon. Except in a few cases, however, veterinary surgeons are not employed in the treatment of the udder troubles of the sheep, and the ewe with a mortified gland is generally left to take her chance, and if she does not die from general blood poisoning, or shock, she usually drags along a miserable existence for months, until the gland has separated and dropped out, and she rarely does much good for her owner. The sloughing away of the dead parts should be encouraged, and antiseptic dressings used freely, for the stench is abominable. In cases of mammary congestion and inflammation, milk-producing foods should be avoided until the crisis is passed, and a lowering rather than a stimulating diet is desirable; but where gangrene is the termination, highly nourishing food and tonic medicine should be given to sustain the strength. —" VETERAN " in *Farm and Home.*

When Foods are Scarce.—Where the supply of food that has been grown runs short, the only thing to do is to grow more. Unfortunately when winter is here there are few crops that can be sown which will be available as food before the new grass crop comes; and the difficulty lies in keeping the stock going up to that time. With the exception of mustard it is difficult to point to any crop which will give assistance, and that is available only in mild districts and in very exceptional weather. One must therefore turn one's attention to the crops which can be hastened into growth. Crops like late-sown turnips, the value of which lies mainly in the tops, can be helped by quickly-acting nitrogenous manures. The " root " crops which are grown for foliage, such as rape and thousand-headed kale, can be helped; and those who possess these crops can get an earlier and heavier yield by manuring, and are not ill-advised in giving this help. There are those who will say that if the growth is forced the animals will scour; if there is not more food,

however, they may possibly starve; moreover, if dry food is given, the tendency to scour or blow is practically stopped. Fresh food, even though it be forced, is not always liable to cause scour. When giving quickly-acting nitrogenous manures to a crop to set in growing there is no need to apply a heavy dressing, for the purpose is altogether different to that where one manures to supply a crop throughout all its growth. To add ½ cwt. per acre of nitrate of soda is to do little more than place at the command of the crop the same quantity of nitrates as might be found available on well-treated land where there had been no washing out of nitrates during winter. When using nitrate for bringing about early growth of rape or kale it should be applied early so that it may have time to get into the soil, for as these dressings are applied not to be useful some long time ahead but as soon as possible, earliness of application is essential.

Crops such as Italian rye-grass, trefoil, rye, winter oats and barley, are also susceptible to earlier growth if manured with quickly-acting nitrogenous manures, and made to give additional feed before grass comes. Of course any permanent or temporary pasture can be aided in the same way. It is the poor pastures that look starved and do not come away until late because available plant food is wanting; consequently, when earlier growth means so much, the advantage of applying a manure which will force growth whenever there is not frost is obvious, and the cost per acre is small. Manure can do no good whilst it is in the manure-house. It is only effective when on the land; and if it is to help grass to come early it must be on the land early. Unless the pastures are being very heavily washed by rains, the beginning of February is not too early to prevent the worst effects of drought, there is nothing like keeping pastures in good heart at all times.

The extra foods that may be forced are valuable because they give the farmer the opportunity to use what he has with greater freedom, for he knows that the two together are what he has to deal with until grass comes or he sells out in ordinary course. What he has in store is the one thing he is sure about, and he naturally wishes to make this go as far as possible.

Those who are accustomed to rely very much on roots cannot fail to miss them; they make that bulkiness in food which ruminant animals require to properly distend their stomachs to cause the digestive juices to flow, and such animals prefer them to an all-dry dietary. Moreover, they prevent, what is always objectionable, a considerable amount of outlay. But animals can be and have been carried through winters successfully without them. By

no means all cows kept in town and suburban dairies receive roots; and carefully conducted experiments on fattening cattle have definitely shown that beef can be profitably produced without them. Of course no one is wasting litter. In years of plenty straw is often carted into the yards with a freedom that suggests that it finds a job for men and horses when there is nothing else to do. The more litter the more muck. Now everything that can be spared should go into the animal and not underneath it. In fact, the litter should be restricted to the lowest necessity.

All are not blessed with covered yards, or with as many sheltering hovels as may be desirable. The great point is to prevent the need to litter large open yards. There are two ways to aid this; to put up cheap temporary shelters, and to curtail the open space. The littering should, as far as possible, be confined to the space under cover, so that the animals may have a reasonably comfortable bed to lie upon. All straw saved from litter is available for food; and all hay chaffed or chopped is eaten, whilst that given long is to a considerable extent wasted by being pulled from the rack or manger and trodden under foot. Better buy peat moss than tread underfoot hay costing £5 or more a ton. Low prices make for extravagance, and when extravagance has become a custom it is very hard to check it.

The final step towards the conservation of hay and straw lies in the use of the chaff cutter. The best substitute for roots is steamed chaff. The best way to make animals lick up the chaff is to sprinkle it with meal and well mix them together. If the chaffed stuff is poor and has not a tempting "nose," a very small quantity of fenugreek will induce the animals to eat it. Perhaps a few roots may be spared daily, and they will be well appreciated; but with or without them animals can be made to get through winter; if as stores without cake, if as fattening cattle with it.

Dry food can be made to present many of the features of more succulent foods if it is steamed. Steaming is no new practice. It is valuable, because straw, hay, and cavings which are not too sweet, can be converted into attractive and digestible food. There is no need to cut straw very short when it is to be steamed; cavings require no cutting; therefore if straw is shortened to a similar length, that is sufficient. Chaff cutters with an extra fast feed gear, or cutters made definitely for litter cutting giving lengths of 6 or 8 inches, are best suited to the work, as they get through it rapidly. Thorough steaming destroys the germinating powers of weed seeds, so that practically anything may be steamed except weeds with strong poisonous principles, these should not be given to animals.

Tops and bottoms of haystacks which otherwise would not attract animals, can be converted into good food.

Many farmers steam on an extensive scale every year for all classes of stock. Store stock fed on steamed food retain their winter coats better than on any other food, and turn out to grass well. Carefully conducted experiments have shown that animals can be profitably fattened without roots if they eat steamed chaff. It is as a substitute for roots that one looks to steaming in a year of short root crops. It affects the dairy as well as the fattening sheds and storeyards. Extra digestibility is a great point, for animals have more time for rest, and expend less energy over digestion, all of which is gain to them. Cows respond to a slushy or mashy food, and it helps the milk supply, because the dry foods are to a considerable extent restored to their succulent form, just as dried fruits regain some of their properties when steamed or boiled. Cows are now short of flushing foods, because the two most depended upon are in short supply. Roots are scarce, and brewers' grains and distillers' wash are not made in so great quantity, because of the wave of temperance which has overspread the country, partly by choice and partly on account of legislation. This greater temperance thus indirectly hinders the production of the greatest of all temperance drinks—milk.

Malt, of course, contains the principles which make grains a milk flusher, consequently malt may be used with advantage. Some loss of food value occurs during malting, but the new property given in malting will counter-balance this unless the malting is carried too far. Amateur maltsters are liable to make the mistake of going too far with malting. It is not uncommon to see barley malted in the granary with shoots, showing well beyond the end of the kernel. This the professional maltster does not do; he stops when the shoot is a third of the length of the grain; it has to be remembered that the shoot of barley starts at the lower end of the kernel and grows up under the husk, and it is the third of the length of the kernel under the husk that is the limit of advantage; anything beyond is waste. Oats certainly help to flush milk, as do malt combs or combings, and both these may be used with special advantages. Calf foods have been improved of late by the better methods of incorporating digestive oils which are a good substitute for cream. In spite of the high price of milk, and in view of the smaller number of calves likely to be reared, and consequently high prices for young stock later on, few will regret using a little to give their calves a start, even though it be but for a few days.

In a year like this every "life" brought round to grass again

must have good value, consequently some of the economies suggested are likely to well repay those who take extra trouble during the coming months.—*Live Stock Journal Almanac.*

The Size of Holdings.—Amongst the many factors affecting the profitable cultivation of the land, the size of the holding is one of considerable importance. It is influenced to a large extent by the capital available, but even assuming the capital to be sufficient in either case, there must be a marked difference in the economy with which holdings of different sizes can be worked. Practical farmers are generally in favour of a holding of moderate size, varying with the quality of the soil and the kind of farming adopted, but running between 200 and 500 acres as a rule, or possibly up to 700 or even 1,000 acres in certain cases. They have found from experience that this class of farm usually provides sufficient scope for their energy and directive power, that it is large enough to warrant the use of a good deal of labour-saving machinery, that different branches of farming can be practised so that their eggs are not all in one basket, and that with ordinary care and business ability a sufficient margin of profit is possible to enable the farmer to live and bring up and educate his family in a manner suitable to his position and capital.

The theorists, on the other hand, appear to have divided themselves into two camps. There are those who advocate small holdings, and would appear as if they believed that land can only be cultivated successfully in small lots, and that the panacea for every evil connected with agriculture is to be found in the cutting up of the land into holdings of fifty acres and under. A new school has, however, recently arisen that advocates the throwing together of farms, the grubbing up of hedges, and the cultivation of the land in large tracts by power-propelled machinery and labour-saving devices of every kind. These advocates of the large farm claim that the grubbing up of the hedges alone would add the area of a good-sized county to the cultivated land of the kingdom ; that by the employment of mechanical power for the ploughing and other processes of cultivation the work would be done quickly at the time it is required, and that both capital and labour would be more efficiently employed. Their most curious claim, however, and one on which they appear to lay considerable stress, is that these large farms would create a demand for skilled and specialised labour, not only in the ranks of the better-class labourers, such as expert thatchers, trussers, and engineers, but would also create a demand for skilled and educated overseers, managers, and accountants from the agricultural colleges and schools.

The question of the displacement of the existing farmers by these

overseers and managers does not appear to have entered into the calculations of the large farm theorists, but we would point out that the large farm was strenuously advocated sixty years ago by Mechi and other supporters of steam cultivation. The contentions in its favour were exactly the same as now—efficiency in the employment of labour and capital—and yet it never proved a success. There are large farms to-day, 3,000 and 4,000 acres, but the men who run those farms are men of exceptional business ability, and few farmers, even if they had the capital, would care for the worry and responsibility entailed. Some of them are excellently farmed, but we have yet to learn that they provide remunerative posts for college-trained managers or higher wages and increased opportunities for the agricultural labourer. The national question is, however, whether they produce more per acre than the smaller farm. It is not merely a matter of cheapness of production, as some economists would have us believe. It is quite possible to imagine wheat grown at 50s. an acre, but what would be the yield per acre in a few years? Cheapening the cost of production is only one side of the question; it is increased production that is wanted. It is far better for the country if £9 is spent by the farmer in producing £10 worth of wheat than that £4 only should be spent to produce £6 worth of wheat, though the profit to the farmer is greater.

There is probably a use for large farms in this country as well as small, provided both are efficiently cultivated, but the average farmer will still pin his faith to the farm of moderate size. It is small enough to allow that individual attention to detail that is so essential to successful farming, and yet is large enough to justify the employment of a good deal of machinery and a staff of men for whom useful work can be found at all periods of the year. No actual statistics seem to be available in this country as to the farms that really pay best or as to the distribution of the cost of labour on different sized farms, though such figures appear to have been collected in the United States. In a series of articles appearing in "Hoard's Dairyman" of which a resumé was given in the "International Review of the Science and Practice of Agriculture," a table was published showing the "labour-income" of the farmer on farms of different sizes in Livingstone County, New York. Here the farming methods and conditions approximate somewhat closely to our own. It is a corn-growing, general farming and dairy region. The figures relate to 579 farms.

The term "labour-income"—a good one—is used to represent the wages earned by the farmer for his work and supervision. It is arrived at by taking the gross receipts and deducting from them all

expenses as well as 5 per cent. interest on the capital. The balance is the value of the farmer's own work. Reckoned in this way with regard to the 579 farms, it was found that on those under thirty acres the average labour income was only £11 a year, on those from 31 to 50 acres it was £59 a year, on those of 51 to 100 acres it was £87, from 101 to 150 acres £118, from 151 to 200 acres £186, and from those over 200 acres, the average being 305 acres, the labour income was £216. By adding the 5 per cent. on the probable capital to represent the total income it will be seen that these incomes are much as should be obtained here on farms of the same size in normal times. It will be noticed how the value of the farmer's own work increases with the size of the farm; indeed, it is pointed out in the paper that many of the small farmers earn less than they would get as hired men. The larger farms are better equipped with horses and machinery and labour can be economically employed.

It will always be found very difficult to industralise agriculture. It is too dependent on the weather and on individual judgment to be run on the same lines as a factory. The same operation performed on two consecutive days may give very different results in the yield of crop, and plans made overnight may have to be countermanded in the morning. Individual judgment is too important a factor of success to be deputed to others. It is just this that makes the difference between the successful and the unsuccessful farmer. The small farmer who does the greater part of the work is in a position to do this to an unlimited degree, but on the other hand he may be handicapped by not getting the work done at the right time. The returns of the small farmer are bound to be small unless he can concentrate upon produce that yields a high return per acre. The good farmer, both large and small, is an asset to his country, but the man who produces the greatest value per acre is the one of most use.—*Agricultural Gazette.*

Thatching.—Thatching, like ploughing, milking, and half-a-dozen other jobs on the farm, looks a very simple operation to the onlooker, but in reality to thatch a rick in a quick and workmanlike manner takes a considerable amount of practice. Thatching is not an easy thing to learn from written instructions. A practical demonstration is better, but only practical experience is sufficient. The young beginner will find that the first three or four ricks he thatches look very homely to say the best of them. However, everybody must make a beginning, and perhaps a few lines from an experienced hand may not come amiss.

The mode of thatching most practised in the West country is by good wheat straw drawn into haulms and fastened with spars. The

spars are made from split hazel and willow sticks, and the making of them is quite an art in itself. They run in price from 9s. to 10s. per thousand, and are therefore much more costly than the peg and string mode of securing the thatch. The only advantage, as far as I can see, in using spars is that they give the finished rick a much smarter appearance. Corn ricks should be thatched without delay, but it is not advisable to thatch hay ricks too soon. A hay rick should be trimmed up as soon as possible after being made, the second day after if practicable. A rick well trimmed and roofed up will not hurt for a week or so, even if not thatched, but in ordinary cases a rick is generally safe to thatch about ten days or so after making; it has generally pitched enough by then. The first thing is to make the roof of the rick square and true. No matter how the roof was left it is pretty certain to have gone a little, if not a good deal, out of shape. The expert will, however, soon put this right. A bit out of a hard lump is pulled and pushed into any soft places, and the crown of the rick pushed up level and true; a high corner is pulled off, and any soft or low places in the eaves brought up level and true; a deft touch here and there, and in a few minutes the roof is shaped. It is a moot question where to start. One expert I know used to start on a corner. The usual way is to start on the north or east end. Then take a bundle of haulmed straw and start by laying the first haulm down on the eaves, butt downwards. Then lay a haulm above, crop downwards on the first haulm in such a manner as to shoot the wet downwards, and so on to the top of the rick. It is a good plan to spar each of these first haulms as you go up so as to keep them firm when you come round to finish here. Then lay another haulm on eaves, join firmly and evenly with the first, and so on to the top again, but you do not need to spar the under haulms. The only spars I use, except at the corners, are to fasten the bond at the top and on the eaves.

The chief art in thatching—which I would impress on all young beginners—is to join the haulms properly, and to keep the roof firm in under the thatch. Mere thickness of straw will not keep out the wet. Two inches of straw well packed together will keep the wet out better than six inches more loosely laid. When you get to the corner (that bugbear of novices) pull the hay, some one side and some the other, leaving the corner on the round. There is nearly always a soft place each side of the corner, and the hay pulled in here comes just right, and will give the rick a much smarter appearance. If you want to lengthen the haulms at corner put the haulm in position, and, holding it firmly by right hand, work the straw up with the left, but be careful to push the straw together afterwards. As

you come round, a band of straw should be sparred on at the eaves about eight inches from end of first haulm, and another at the crown about eighteen inches from top. The eaves should be packed level as you come round, and the odd ends trimmed off with the shears, and at the crown the straw should be worked up straight and true, and also trimmed level with the shears. It is not considered good work to twist these bonds of straw, or only very slightly. There is quite an art in driving in the spars at eaves and crown; when driven in the proper way no wind will ever shift them. You take the spar by the twist, and, letting the bottom haft take the rick four or five inches below the bond, drive it in an upward and oblique direction away from you, letting the top haft come across the band.

It makes a lot of difference how the haulms are prepared for the thatcher. A thatcher, no matter how expert, is greatly hindered by badly-made haulms; it is necessary to make them all of a uniform size. There is nothing more annoying than to have to put on haulms of different sizes, and well-made haulms go a long way towards efficient thatching. A good sized haulm is about sixteen to eighteen inches across. It is a waste of time to mess with handfulls of straw about six inches wide, which is very often about the width when it is piece-work. Another mode of thatching I learnt as a boy from one of my father's men was with straw not haulmed at all, but pulled out straight in bundles, and only wetted on morning of use. You take a bunch of the straw on the left forearm, butt downwards and spread it on the rick, combing it towards you with your fingers to get it level, and then push it together firmly, and, of course, start at the eaves as before. Then you take another armful of straw and throw it across the other, but downwards, and down towards the eaves somewhat low. Then, after straightening the straw, you work it up the roof with the left hand, holding it firm with the right arm, and so on up to the top, sparring about mid-way up the roof, care being taken to push the straw firmly together as you go. Straw direct from the threshing machine tied with the butts all one way as usual can be used in this way without any preparation, and when put on well presents a wonderfully neat and finished appearance. No rake is used to comb it down, but it is straightened by the hand as you go, and all the straw put on butts downward, not an ear showing; this mode of thatching lends itself well to thatching round ricks. But it is not so simple as the former mode of thatching with haulmed straw, neither is it so quickly done, and it takes more material. Every farmer ought to know the way to do his own thatching, partly because it is rare to find a man who can thatch decently. Nothing looks better on a farm

than well made and well thatched corn and hay stacks. It is vexing to go to the expense of growing and harvesting crops and then to see a good part of them lost through bad thatching. Such is, however, frequently the case.—"SOMERSET FARMER" in *Farm and Home.*

Increased Calf-Rearing.—Various circumstances have recently combined to direct attention to the desirability of rearing a larger number of calves, so as to increase the home supply of store and fat cattle. There is, first of all, the improved price for beef, which is likely to continue, because the farmers of North America have practically ceased to contribute this article to our markets, and the States now compete for a portion of the surplus from South America. So far the Argentine has been able to meet these demands, but there are indications that it may be found difficult to maintain the output on the necessary scale. The meetings of several of the South American companies have shown that profits have diminished owing to the higher value of the cattle, and unless there is a substantial profit the impetus requisite for large expansion will be lacking.

Then, the interruption of trade from Ireland owing to the restrictions caused by outbreaks of disease has greatly reduced the number of store cattle sent from that country and has raised the prices. That this shortage has not been more severely felt is probable partly due to the fact that grazing prospects have not been bright, grass having been deficient during the early season. Numerous reports have, however, stated that at the relative prices of fat and lean cattle there was little prospect of any profit to the grazier, and the consequence is that pastures are believed to be insufficiently stocked. If so, the probability is that later the supplies of fat cattle will diminish and prices may further substantially advance.

It should not be overlooked that efforts are being made to establish a dead meat trade from Ireland, which, if successful, may, in time, lead to a considerable change in the traffic, and to the fattening of a larger number of stock there.

All these points, and others that might be mentioned, give additional force to the contention that more calves should be reared. The question is not confined to this country. It has been keenly discussed elsewhere, and in some cases drastic measures have been advocated to compulsorily prevent the sacrifice of young calves. It is doubtful, however, if in such a matter any benefit can arise from interference with freedom of action. Here, at any rate, no such methods are practicable, and all that can be attempted is to point to the facts, and advise that they be carefully considered. Something might probably be done to bring the owner of surplus

calves and the intending buyer into closer business relations. The action of the Board of Agriculture, under the live stock improvement scheme, placing a better class of bulls within the reach of the smaller farmers, should help in the same direction, but this will take time, and the movement seems to progress rather slowly.

Sometimes the advice to rear more calves is resented as an interference with freedom of action on the part of those interested. But this is not correct. If it pays owners of calves to feed them as veal, a legitimate demand is being met and it is for stock-owners to supply it. Where the waste comes in is in the many thousands of calves that are slaughtered soon after birth. The owners are only anxious about the milk supply and get rid of the calves as soon as possible, as they have no facilities for rearing them and there is no one near who cares to buy them. It is probably true that in many cases the calves are a poor lot and are scarcely worth rearing; but they cannot all come under this category, and by the use of a better type of bull an improvement might soon be effected. In this way, and by bringing seller and buyer more closely together, some improvement is possible.

The demand for beef is likely to continue good, and the business of feeding would be more attractive if stores could be obtained at a lower, though still remunerative price. It would be very gratifying if some practical steps could be taken to deal with the subject on sound commercial lines. The market appears to exist, if the parties interested could be brought together, and it is to be hoped that something will soon be done.—*Live Stock Journal.*

The Value of Fleece.—Wool has been an asset of increasing value for some years past, but the prices realised at recent sales have far exceeded the best returns for several decades. At present prices the fleece adds substantially to the value of an animal, putting 8s. or 10s. on to the price of a good ewe, more or less according to the character of the wool. The rise has been correspondingly liberal in the cases of long-woolled and mountain breeds, all grades participating in the quickened market.

There is no article of more importance in regard to which this country compares favourably with foreign countries than wool. We are not independent of imports, vast supplementary quantities being introduced largely from Australia and South Africa. This country has access to the finest wools from the great pastoral countries of Australasia, South America, and South Africa, but in view of the difficulties of transport it is a fortunate circumstance that we are relatively well provided for from our own flocks. Sheep-raising is not prominent as a pursuit in the public eye, being gener-

ally ignored by untutored critics of our agricultural systems, but at a time like this it fills a place of importance and makes a valuable contribution in wool, as well as in mutton, to the resources that constitute national stability. The present liberal prices for wool will direct greater attention to the cultivation of the description of fleece that finds favour in the market. For at least a generation the fleece has been subordinated to the carcase, all the efforts of the flockmaster having been concentrated upon the production of mutton, rapidity of growth and early maturity being the main ambition in the selection of breed and the propagation of strain. The results achieved have testified to the skill with which efforts have been directed for the attainment of the best economic returns. The fleece, however, has not been neglected ; it has merely remained unaltered except in the case of the few breeds the evolution of which has been dominated largely by a lucrative export trade. The changes effected for mutton production have not actually been prejudicial to the quantity or quality of the wool, and whatever efforts may now be made to obtain a fleece of superior value, it is improbable that the qualities developed in recent years will be allowed to suffer. The supreme importance of the carcase is unlikely to be overlooked, and the fleece will be modified in the Down breeds only in so far as this may be compatible with the maintenance of rapid growth and early fattening.—*Field.*

Promptings for Harvest.—Given up-to-date binders, capable of dealing with almost any kind of crop, and a staff of general labourers, persons not fully conversant with the details of harvesting, and also many whom one would expect to know better, may be led away with the idea that the master's work on a farm is reduced merely to giving orders and finding the " necessary " for Saturday night.

All practical farmers will cast such notions aside, and give personal attention to such details as may help them to avoid some of the losses accruing from a wet harvest.

With ordinary well-ripe and standing crops there is no trouble, so long as the corn is not cut when wet. All that is needed is a sharp knife and plenty of power before the machine. It is the bulky and partly laid crop that calls for special attention. Such a crop requires that the machine be nicely manipulated. For barley this is particularly the case. Just as the barley crop varies in its loll on different sides of the field, so is it necessary, if a good sheaf is to be turned out, that the reel be raised and lowered just as the corn lies from or to the machine on its progress. With long, broken straw it is necessary that the " table " of the binder be shifted to arrange for the band of string to be passed round the sheaf as near

to the ears of corn as is possible. This is an important matter for several reasons. If there be any amount of green matter, clover or other stuff, it is desirable that the butt end of the sheaf be as open as possible to allow it to "weather" more quickly; and, again, when in stook the greatest number of grown corns are found when the barley heads hang over and touch the ground. If these heads are nicely gathered up, and the string be within a foot from the top of the sheaf, it is much easier for the men stooking to pack the sheaves nicely together.

When corn is so laid that it is impossible for the machine to tie a decent sheaf, it is advisable to cart the bundles (for they will not be anything better, even if the machine has managed to get a band round them) straight away and stack to themselves. With such laid corn there is not much likelihood of there being any green matter, and it will not be fit to mix with the general crop. It is with such sort of corn that the greatest amount of sprouting takes place in the stook. Many farmers, where labourers are plentiful, set them to mow out such places; however, if the corn be dry and not actually lying directly from the machine, it may be managed.

Stooking is work that is more important than is generally appreciated, particularly with barley. For stooking to be done properly at least two men must work together. For stooks to stand well, it is necessary that the first two sheaves be well planted. These sheaves have to bear the weight of the others, for although each pair of sheaves, as they are set up, should stand independently of the others yet there is always a shrinking of the sheaves and a gradual settling towards the middle sheaves. It is necessary that an equal number be set up either side of the first two, so that the weight is evenly distributed. This applies more particularly to wheat and oats. Certainly not more than seven or eight sheaves should be on either row of the stook, and the sheaves should stand at such an angle that there is room for a free current of air to pass between the rows. Stooks standing in such a position, in even a wet time, will be found in a much better condition than those that have been set up without any regard for eventualities. Labourers working "by the piece," as a rule have most regard for their own interest, their main anxiety being to get through as much work as possible.

In stooking barley there is even more need to watch that the work is done properly. One side of the sheaf—the one that has lain on the "table"—has very few heads showing, it is *flat*, and the straw is very straight; the other side is rounded, and shows a lot of heads. Unless men are watched, they are not particular which side they place inside. If the *flat* side be turned outside there are but

few heads exposed, and the straw lying straight is like thatch, and will turn a lot of rain. The heads of the barley being inside, escape the rain and consequent bleaching. In an ordinary fine harvest a nice rain when corn is in stook has rather a beneficial effect on the barley, in many instances mellowing it. One can, however, have too much of a good thing, and exposure to continual drenching very soon takes off the bloom.

Another matter with reference to stooking is worthy of attention —*i.e.*, the direction of the rows—these rows should point north and south. At first sight this may not appear a matter worth remarking on. However, with September dews it will be found that by stooking as indicated the sun soon dries all off very early in the day, getting on both sides of the stook; whereas, if standing in another direction, east and west, the north side of the stook will remain damp very late in the day; in fact, will require to be pulled down to allow of the sun getting on it. In a catchy harvest the narrow stack will allow of the corn improving in condition.—"J.A.G." in *Agricultural Gazette.*

The Oil Engine.—With labour so scarce and horse-strength upon the average farm at a low ebb, the stationary oil-engine may be looked upon as a most valuable and helpful friend of the farmer. The initial cost is not heavy, the running expenses are light, and what is of very great moment such an engine can soon be properly run by anyone of ordinary intelligence. Once installed its aid is available whenever wanted; it can be started without the delay necessary to get up steam, and may be run for hours without further attention than to see that the supply of oil for combustion is properly kept up and that the bearings are lubricated as may be necessary.

Oil-engines may be had of various powers to suit the particular needs of the farmer. It is generally best to buy through a local agent who, besides supplying the engine, will see to its being properly fixed and that it is in correct working order to begin with. The oil-engine is capable of doing many things helpful to the farmer, amongst which come prominently chaffing, pulping, grinding, threshing, pumping and wood-sawing, not forgetting milking, should it be desired to do this by mechanical aid.

Because the oil-engine is such a jack-of-all-trades it is of first importance that the engine be fixed in such a position as will enable its power to be most readily available for the various duties required of it. Before fixing the engine, therefore, the farmer should himself consider the matter over carefully, and before finally deciding should consult with the agent from whom he intends to purchase

the engine. Such agent, if not an engineer by profession, has generally had wide practical experience in this particular, and, a satisfied customer being proverbially the best advertisement, will in most cases advise the farmer for the best. Much depends upon the general plan of the farmstead as to where fixing had best be done, and each case must, therefore, be considered upon its own merits. By means of properly fitted and designed shafting, supplemented by adequate belting, engine-strength can be distributed in many directions, so as to be surprisingly handy.

In choosing the site for the oil-engine it sometimes happens that because horse or steam power has been provided at one particular spot the oil-engine is, without further consideration, fixed at the same point. Before doing this consider matters carefully and see whether a new site might not make for more all-round handiness. A move may, perhaps, mean a little more expense at first, but it may also mean much better service ever afterwards. At any rate, study the matter carefully.

The oil-engine needs to be both firmly and properly fixed; therefore its fixing is not a job for 'prentice hands to undertake. The heavier the engine the more firmly must it be secured to its bed, which is generally of concrete containing embedded metal to which the engine is bolted down. Before working the engine, allow time for the bed to become properly set. The workmen who fix the engine will be able to say when work may be safely undertaken, it being always best in this case to abide rigidly by instruction. Frequently the engine can be fixed indoors, but, if not, a special shed should be put up, for full protection from the weather should always be provided. Good and lasting housing for an oil-engine can be made by covering a properly constructed framework with corrugated metal sheeting.

Before starting to work the engine learn all that you can about its mechanism. Endeavour to learn what every portion is called, but be certain you understand the function of each part. Have the engine started and stopped several times in your presence, and before the instructor departs try the engine yourself. It does not betray ignorance to desire to study a new thing properly, it is much more foolish to miss the opportunity of learning.

A great virtue of the oil-engine is that it rarely goes wrong except through wear and tear; then, of course, a fresh part becomes necessary. Being so "foolproof," as our Yankee cousins say, it can be worked when the farmer himself may unavoidably be absent, just as confidently as when he is present either to take charge himself or to overlook. When work is over for the time being, the engine may

quickly be stopped, and no further working expense is incurred until the engine is again started for immediate service.

Where once an oil-engine is installed it is quickly looked upon as indispensable.—" J. T. B." in *Mark Lane Express Almanac.*

The Stack.——In the matter of the shape of a haystack there is something to be considered besides mere fancy. We may have a fondness for a large square rick, in which the space is so ample that half-a-dozen loads of hay seem to make no impression upon it while building is going on, but we cannot always indulge our fancies with building such a stack, although the hay may be available and the men there to get it together. The fact is, the weather and the climate and the composition of the grasses in the meadows have all a voice in determining the size and shape of the stack. In the south of England, where the sun is mostly in evidence daily during the regular hay season, and where the rainfall is comparatively small, there is nothing to prevent large ricks being built unless the meadows are so full of " herbage " as to make overheating a certainty if the hay is not almost as dry as dust. With such weather and in such a climate the farmer—in average seasons—can go to bed without any anxiety as to his hay being spoilt by the rain, although the stack may be left perfectly flat and without the protection of a rick sheet or a Dutch barn. In a district where the rainfall is greater, and where, in consequence, the periods of fine weather are less prolonged, the haymaker cannot incur such risks. Nor is it to his advantage —either as regards money or labour—to gratify his wish for a big rick at the expense of having to " roof " his stack each night, and to set out the sides again the following morning. His experience has taught him that the " long narrow stack " is the best for his purpose, as it enables him to put the hay into safe quarters at the minimum of trouble and expense, and he can feel that the work of ingathering is practically accomplished as soon as the hay has been lifted from the waggon or the cart. To the more favoured individual the comparatively narrow stack may seem a gigantic mistake, because it adds to the weight of refuse hay in " tops, bottoms, and outsides " ; it entails more labour and thatch in covering it, and in some extreme cases and seasons it may mean that the very limited dimensions of the stack prevent that gentle heating so much desired by those who like their hay to cut " solid," and the fodder is little better—on account of its extreme dryness—than mere straw. But these drawbacks—serious as they may be—are trifling enough when compared with the difficulties connected with the cutting of an over-heated stack, especially when the hay is on the verge of becoming ignited; and so one may rest assured that plans which have been found to

answer well under certain conditions will not be hastily abandoned in favour of others, which may be well adapted for certain localities, but which, so far, have not been tested in one's own.

In some of the south-western counties the round stack is in favour. I cannot explain why this should be so, unless it is another piece of evidence as to the survival of the fittest. The difference of opinion as to the shape and size of stacks is not confined to hay-stacks alone, for in some counties we find the wheat ricks so large that they will swallow half-a-dozen of the stacks which would be typical of another county. These small corn stacks are found in the later and wetter districts, and they are, as a rule, built on rick-frames or staddles made of stones and timber or bricks—in fact, the frames are permanent erections. Their size is an indication of the caution which was observed by our predecessors in building stacks which were sometimes intended to stand for a year or two, and we may be sure they knew perfectly well what they were about. The size and shape of hay and corn stacks may be a subject which, to the casual observer, admits of no difference of opinion, but the above remarks will show the reader that even in so trifling a matter there are many considerations involved which the farmer cannot afford to pass unheeded.—" STAFFORDSHIRE " in *Farm and Home.*

The Three Best Geese.—Although there are eight distinct breeds of domesticated geese there are only two bred at all extensively in this country—the Toulouse and the Embden. Another very good variety is the Chinese, but there are very few in this country. They might be kept in much larger numbers, however, since they possess excellent economic qualities.

The Toulouse goose is mostly in demand for supplying the Christmas markets, as it attains to a larger size than its chief rival, the Embden. A goose of similar characteristics to the Toulouse has been in existence in this country for many centuries, and while the present day Toulouse is larger and probably possesses rather finer flesh, it is certain that the two are closely allied. So far as one can determine, the improved size and quality of flesh are due to the introduction of foreign blood, the cross having taken place in the South of France about 150 years ago. At first this breed was known as the Mediterranean, then as the Pyrenean, and finally as the Toulouse, though so far as one can tell they have no closer connection with the town in France of the same name than they have with many other cities. As already mentioned, the Toulouse is a large bird, an adult gander averaging from 23lb. to 28lb., and a goose 21lb. to 26lb. In America the general type is rather smaller, the males there weighing from 20lb. to 25lb., and the females 18lb. to 23lb. The general

appearance is that of massiveness and great depth of body, the breastbone or keel frequently almost touching the ground. The body is long and deep, and very prominent in front; the paunch is heavy and is carried low; the back is broad and somewhat curved, and the shoulders are broad. The neck is long and very thick; the head is broad and thick, and the bill, which is orange in colour, is strong, forming a uniform curve from point of bill to top of head; the eye is large, dark in colour; on the throat is a heavy dewlap, an undesirable point, often exaggerated in show birds, leading to weakness and disease, and indicating a loose skin; the tail is high and full; the legs are short, heavy in bone, and toes well spread, in colour orange; the back, wings and thighs are of a dark, even steel grey, each feather laced with a much lighter shade, almost pure white, except the flight feathers, which are of a solid steel grey; the breast and under parts are of a clear grey, lighter on the thighs, and the stern, paunch, and tail are white, with a band of grey across the tail.

The Embden goose is pure white in colour, a point slightly in its favour since the feathers are rather more valuable. In appearance the Embden is very similar to the Toulouse, but it is not quite so squatty, standing more erect. Its neck is long and swan like, and the head is also long and fine. The bill is of the same colour as that of the Pekin duck, namely, bright orange. The legs and feet are also of this colour. The dewlap, which is such a special characteristic of the Toulouse is altogether absent. The eyes are of a light blue colour, and are large and full. The general appearance of the body is slighter than that of its rival, and it is not quite so deep in front. The breast should be broad and solid, and it should have a very slight indication of keel. The leading characteristics of Embden geese is their rapidity of growth, which is a very important point in their favour, one that will probably increase their popularity in the future, even more than has been the case in the past. At an age when the Toulouse is in very raw, lanky condition, quite unfit for killing, the Embden is plump and fleshy, so that we find that the latter is chiefly depended upon for the autumn trade. During the last few years I have carefully compared the geese exhibited in the dead classes at the Dairy and Smithfield shows respectively, with the result that at the former, which is held in October, the Embden predominates, whilst at the latter, held in December, the Toulouse is more in evidence. As a question of cost of feeding, the Embdens can be brought into a condition for killing the more cheaply, especially as they do not need much beyond the usual stubble feeding, and thus the comparative returns would be

greater, unless a much higher price could be obtained at Christmas, which of late years has certainly not been the case. The quality of the flesh of the Embden is superior to that of the Toulouse, being fuller in flavour and not quite so coarse. With regard to the egg producing qualities of the Embdens, although the eggs laid are rather larger in size than those of the Toulouse, yet the number produced is small. The average number laid is only about 26 to 30 per annum, whereas its rival will lay as many as from 45 to 55.

The Chinese geese have an economic value chiefly for their excellent laying powers, and, while their eggs are smaller than those from the Embden or the Toulouse, they produce a larger number, and commence to lay earlier in the season. Their flesh properties are not everything that could be desired, although as far as this is concerned there is a considerable diversity of opinion. In a report of these birds, published by the Rhode Island Experiment Station, the following remarks concerning the meat qualities appear :—" Chinese geese are not favourites with those who raise goslings for sale to poultrymen, who fatten them and put them on the market as green geese. They are too small to be profitable for such a market. When a small-boned, moderate sized goose is required for the fall or Christmas trade, these birds would prove valuable, as they lay well and, with proper care in selecting breeding stock, large fowls could be raised. The brown goose specially seems very vigorous, hardy, and active, but plucks hard and requires care in dressing to look well. The white variety is usually not so difficult to pick, and is handsomer in appearance when dressed. Chinese geese closely resemble Pekin ducks in appearance, in that the body is carried upright, the legs being placed well back towards the tail. The neck, too, is extremely long, probably explaining why they are sometimes called swan geese. As in the Toulouse, there is a large mass of folded skin under the lower mandible, termed the 'dewlap.' The head is rather larger, with a graceful bill, sloping gently towards the head. At the root of the upper mandible there is a knob, about the size of a pigeon's egg, which in the case of the brown variety is black, while in the white it is orange coloured. The colour of the brown variety is a greyish brown on the back, grading to white on the abdomen; the neck and breast are yellowish grey, with a dark brown stripe running down the back of the head to the body : the head, wings, and tail are dark brown. In the white variety the plumage is pure white, with bill, legs, and feet orange. As already indicated, Chinese geese are by no means large birds, the adult gander averaging about 16lb., and the adult goose 14lb., a year old gander averages 12lb., and a goose 10lb."—" EXPERT " in *Farm and Home.*

The Farmer's Library.

NOTES AND REVIEWS OF NEW BOOKS.

1.—*Agriculture after the War.* By A. D. Hall, F.R.S. London: John Murray. 3s. 6d.

After the war. What wonders are going to be done in this much-to-be-desired future! Some people may ask, and not unreasonably, why were not these things done in the past? Why did not those who are ready to show us the right road now point it out years ago? Unfortunately these men would not then have been listened to. We have been far too self-satisfied, and those who think all goes well scoff at the few far-sighted and deep-thinking individuals who see the truth. Those who spoke, like the late Lord Roberts, were not listened to. It is as useless to point out facts to the self-satisfied as to ask a blind man to look at a landscape.

The war has changed this. Many sleepers have been wakened. Now is the time to impress upon them the need for great changes in the future, and there are few men more competent than Mr. A. D. Hall for this task so far as regards Agriculture. As Principal for many years of Wye Agricultural College, he was in a position to gauge the educational work of the country as it affected those who were to live on or by the land. His intimate relations with farmers both then and since showed him what the farmer of to-day lacked; and subsequently his work, first as director of Rothamsted and then as one of the Development Commissioners, showed him how backward this country, and especially its State departments, have remained with regard to the scientific aspects of agriculture. So far as the State is concerned he says "of the need for the adoption by the State of a considered agricultural policy for the better utilization of the land of the country I have no shadow of doubt."

Mr. Hall recognises facts and sees clearly that the development of the land and the price of agricultural produce must, and always do, go side by side. Thus he writes —

> "The degree to which arable farming may be extended or even maintained must, however, be limited by two factors—the average price of the chief agricultural products, wheat and meat for example, and the price of labour."

"With wheat at about 35s. per quarter arable farming was distinctly prosperous."

"If prices again go down to the level that was reached in the 'nineties' and wheat has to be sold at well under 30s., all these prospects vanish."

We must therefore in the first place ensure for the farmer a fair price for his produce, and if this be done then we may hope and reasonably expect further developments to take place in British agriculture. Many people think that the absence of development in the past is due to the want of knowledge on the part of the farmer, and failure to use the artificial aids of manures and feeding stuffs which were available. The fallacy of this argument was recognised by the late Sir John Lawes who laid it down as a maxim that "high farming is no cure for low prices."

We doubt whether even to-day the average townsman has learnt to realise how dependent this country is upon its agriculture, not merely for food, but for men. The State has also failed in this respect and neglected the industry. It is partly the fault of farmers themselves, who have far too frequently selected as their representatives in Parliament men who neither understood their industry nor cared for those engaged in it, but sought a seat in Parliament to further their own ends.

The author assumes a better future for agriculture and points out how farmers themselves, landlords, and the State, may and should further this development. Education must of necessity take a leading part in bringing about these changes—the education not merely of the farmer in his business but of the landowner, the statesman and "the man in the street." In the past, the last of these has been educated mainly through the newspapers, and unfortunately in many cases wrongly educated by men who had some axe of their own to grind rather than the furtherance of truth. Statesmen have been too much impressed by the voice of the towns, and landowners have had no opportunity of properly studying their functions while at the Universities. The Universities are not concerned with the education of the farmer but mainly with that of men who will probably become the landlords or landowners of the future. To expect such men to study the technical details of farming is contrary to reason. The wise founder of the Sibthorpian Professorship at Oxford, for the promotion of the study of Rural Economy, evidently recognised this. This is a subject not only suitable for the majority of University men, but essential for those who look forward to becoming either statesmen or landowners.

Agriculture, either in theory or practice, is however widely distinct from Rural Economy, and the sooner the Universities give attention to the study of the latter, not merely as illustrated by home practices but by world-wide experience, the sooner is this country likely to develop. The technical study of agriculture may be left to the many agricultural colleges which have sprung up of late years.

To those who desire to see some improvement of agriculture in the future, we commend this book. The chapters upon "Possible Developments" and "What action is practicable" deserve close study by all those engaged or interested in agriculture. The statesman, the landlord, and the farmer should each well consider the subjects discussed. The last of these is often inclined to ignore writers because they are frequently devoid of technical knowledge and wanting in sympathy. No one could accuse Mr. Hall of the first, and the following words, from his Preface, as also the book itself disprove the second :—

> "Before one attaches any blame to the current race of farmers one must consider the extraordinary crisis through which they have passed in the last thirty years without any attention or assistance from the State; then one will be more inclined to praise them for having contrived to remain in existence at all."

2—*Organic Agricultural Chemistry.* By J. S. CHAMBERLAIN, Ph.D. London: Macmillan & Co. 7s.

Those who of late years have had an opportunity of studying agricultural literature, especially that bearing upon the scientific aspect of agriculture, must have been struck with the difference between the output of this country and of foreign countries. It is not merely in quantity that we have lagged behind. In quality, *i.e.*, accuracy, thoroughness, and appropriateness, our books cannot compare with works which have issued from other countries. Whatever may be the faults of political Germany, her scientific literature as it applies to agriculture has certainly been pre-eminent. For some time past the United States have been closely following her lead, and works emanating from the other side of the Atlantic,

as this one does, are rapidly ousting English works, and becoming the authorities which scientific men consult. This should not be. This country should wake up to the fact that we have friendly competitors as well as enemy competitors, and need to pull ourselves together and put forth all our energies, if we would maintain our position in the world of knowledge.

These thoughts were suggested by a perusal of the work of Dr. Chamberlain. It is a distinct advance upon any work in the English language, known to us, which attempts to put before readers, and more especially students, agricultural chemistry in its relation to those organic substances the production of which is really the essential aim and object of the farmer. Most of the works on agricultural chemistry issued in this country are devoted mainly to the soil and to manures. These are merely means to an end, which is the production of crops, and from those crops the production of animals and animal products, *e.g.*, milk, butter and cheese. All these substances are essentially what the chemist terms organic, and it is with the chemistry of these organic substances that this book deals.

The work is divided into sections the first of which is devoted to a systematic consideration of the organic compounds of importance in agriculture, or at least as helping to explain the chemistry of those which are. It would probably be impossible for anyone without a previous study of the elements of chemistry to understand the book efficiently. In our opinion, however, no boy should ever leave school without having had some preliminary instruction in chemistry, that science which properly understood deals with the elements of everything created and known to man, himself included. When we think that our very existence, and that of everything we know, is governed by, and dependent on, chemical action, it is appalling to realize that we are willing as a nation to neglect this study rather than give up the study of people and languages dead and gone centuries ago. Every study has its place; let the essential ones, however, take precedence.

So in agriculture. Chemistry is the foundation of all agricultural science, the unseen, and often undreamt of, controller of all agricultural practice.

Dr. Chamberlain, having made his students acquainted with the bricks, so to speak, which nature uses in building up plants and animals, passes on to a consideration of how they are used. In this second section, which he terms Physiological, he shows the wonderful processes taking place in plants and animals by which they use one material to manufacture another, in ordinary language,

to grow. Unlike most authors, he takes animal physiology prior to that of plants.

The third section is devoted to Crops, Foods and Feeding. Some valuable tables are given, each showing the average amount of a certain constituent, *e.g.*, fat. or protein, or fibre, etc., present in the most used feeding stuffs.

We welcome this addition to the library of the agricultural student and the farmer who has already studied chemistry. Both will welcome it; the former as it satisfies a much needed want, and the latter because of the very clear style of the author, and the systematic way in which the subject has been dealt with, so that like in a well-written French "reader" no word is used which has not been previously explained. We congratulate the author on the production of a scientific text book which it is a real pleasure to study.

3.—*Plants in Health and Disease.* By Drs. F. E. Weiss and A. D. Imms, and Mr. W. Robinson. London: Longmans, Green and Co. 1s. 6d.

A course of lectures was given at The University, Manchester, to assist those who were endeavouring, to the best of their ability, during the present crisis to increase the productiveness of their gardens or allotments. The lectures, therefore, dealt with the peculiar difficulties met with in that neighbourhood, and the accounts given of the animal and fungal pests are descriptive of the more common diseases occurring in gardens and allotments in the vicinity of our large industrial towns.

This book is a résumé of those lectures, necessarily, but unfortunately for the general reader, devoid of the illustrations which accompanied the lectures.

In the first six chapters plants in health are considered by Professor Weiss, who, starting with general features of Plant Life, proceeds step by step to consider the structure and functions of each part of a plant, roots, stems, leaves, methods of reproduction and propagation, flowers, seeds, and the malformations to which plants are subject. The descriptions are clear, devoid of technical language, and throughout keep in mind that practical side of the subject especially interesting to those for whom the lectures were

intended. For those who wish to study the subject further, a list of a few authoritative books is given at the end of each chapter.

Mr. Wilfred Robinson follows with five chapters devoted to a consideration of the fungoid diseases of plants. As a typical parasitic fungus he takes Pythium—the cause of "Damping-off" in seedlings—and subsequently is able to compare other fungi with this as a standard. Then he passes in review the chief fungi which attack roots, tubers, leaves, and shoots. Here again special attention is given to those plants with which gardeners and allotment holders are mainly concerned.

Dr. Imms, in the remaining five chapters, considers the animals and insects injurious to plants and also a few of those which are beneficial. The main object of the study of these injurious causes is to know how to distinguish them with a view to diminish their activities. Unfortunately in our present state of want of knowledge, it is painful to read so frequently such words as "there is no remedy except burning," which, of course, is not a remedy but the resource of despair. Probably in no branch of agriculture is there more need for research than in connection with the diseases of plants, the causes of susceptibility or immunity in plants, and the most efficient methods of dealing with those diseases which cannot be altogether warded off. What little is known regarding the animals and insects referred to by the author is briefly but clearly epitomised. These pests are so numerous that it is not possible to do more than give the most essential facts regarding each. However, by means of numerals attached to each pest treated, the author indicates in what standard work bearing upon economic zoology the student may find further details and information. Nineteen such works are mentioned.

Thus the book constitutes an admirably concise text-book of the subject of Plants in health and disease, suitable alike for the practical man and for the student.

4.—*The Principles of Feeding Farm Animals.* By Sleeter Bull. London: Macmillan & Co. 7s. 6d.

Of the many aspects of Agriculture in which great advances have been made of late years, few, perhaps, can equal in importance and in progress the feeding of Live Stock. The interest in this subject, which is universal among farmers, is partly due to the fact that in every country and in every locality the problem of profitable feeding varies, partly because the natural produce of the land varies yet must be utilised. In later years the subject has acquired a fresh interest, owing to the ever increasing number of substances,—in many cases by-products,—which have been introduced as feeding stuffs. It would not be difficult to make a list of fifty such materials which are used by farmers to-day.

It must be self-evident that these will vary considerably in composition and utility, and the problem the farmer has to solve is how to use them to advantage. This cannot be done by rule-of-thumb methods. The man who is going to make the most profitable use of these materials will be the one who best understands the principles of feeding. Hence, we can always welcome any good work on the subject likely to prove of use to the practical farmer.

There have been many books written upon feeding. Some are only suitable for college students as text-books to be studied side by side with the course of lectures. They have their value, but are too much devoted to the study of theories to be of real help to the practical man, for we cannot ignore the fact that such men have, as a rule, but little knowledge of the scientific foundations of profitable feeding, and but little time for study.

The author of this book starts with a series of chapters on the chemical composition of feeding stuffs and animals. Then particulars are given as to how food is digested; the digestibility of feeding stuffs; and the functions which the digested portions serve in the animal body. These and other subjects lead up to an important chapter on the food requirements of farm animals.

Subsequently, all the various substances used for feeding are considered in a series of chapters dealing each with a certain class of materials, *e.g.*, grains and seeds; cereal by-products; oil by-products; hays, straws, etc.

The efficiency of rations is next considered in a chapter which is far too short for the reader, for it contains much valuable information in almost too concentrated a form. A large number of useful tables and a full index add greatly to the value of the work.

Written in America, originally as a class manual for the use of

elementary students at the University of Illinois, it naturally draws largely on the results of feeding experiments carried out at the numerous U S.A. Experiment Stations.

Probably few Englishmen have any idea of what an enormous amount of work has been done, and is being done, at these Experiment Stations to help make the American farmer the most up-to-date and successful agriculturist extant. But there is another movement also in progress in America, as in this country, and the author in his Preface not only draws attention to it, but mentions it as explaining the course he has adopted in writing this work.

> "On account of the 'back to the land', movement which is sending men from the cities to the agricultural colleges and to the farm a mere discussion of balanced rations and feeding standards has not seemed sufficient. Consequently the author has presented rather definite rules regarding the feeding of the different classes of live stock which, taken in connection with the feeding standards, and the discussion of the nutritive value of the different feeds, should enable the inexperienced feeder to formulate at least fairly satisfactory rations."

We have no such records of Feeding Experiments made in this country on which to build up a work similar to this. On the other hand many of the experiments carried out in the United States are only applicable to that country, or portions of it. Still, they teach their lesson, and add to the general principles on which all feeding is based and which are well set forth in this work.

5.—*Fertilizers.* By E. B. VOORHEES. London: Macmillan and Co. 6s. 6d.

This book, which was originally published in 1900, has been reprinted sixteen times, and has now been revised by J. H. Voorhees, B.Sc., of the New Jersey State College of Agriculture. It is one of The Rural Science Series, several of which have been noticed in previous issues of this Journal. There is neither Preface nor Introduction, so that were it not for a knowledge of the series to which it belongs one would be unaware that it was specially intended for agricultural students and farmers. There are various points of view from which fertilizers may be considered. The manufacturer is interested in obtaining raw products and in knowing how to convert these into marketable articles. The agricultural analyst

is interested in the methods of analysis which enable the composition of each and every manure to be accurately determined. The agricultural chemist is interested mainly in the chemical changes brought about in soils and plants by these fertilizers, and also in the fertilizers themselves.

The agriculturist is not greatly concerned about any of these matters. He is mainly desirous to know what fertilizers are at his disposal and how best to use each. This was evidently the view of the author, for his book might be divided into two sections, the one describing all known fertilizers, and the second taking the various crops of the farm and orchard seriatim, and going fully into the manurial treatment best suited for each.

Will it pay to use fertilizers? is a question which the farmer puts to himself often enough, and which the author also puts and answers in his own characteristic way, as follows:—

> "It must be confessed that to give a definite and positive answer to this question, with our present state of knowledge, is a difficult matter, if not well-nigh impossible, because of the very large number of varying conditions that are involved.
>
> "Usually such a question cannot be answered in a rational way without first securing definite information concerning the conditions under which they are to be applied, as, for instance, the character of soil, whether a sand, clay, or loam; situation in reference to moisture, whether too dry or too wet; the kind of subsoil, whether a loose, open sand or gravel, a medium clay, or a tight impervious hard-pan; the character of the previous treatment and cropping; whether the land has been manured or fertilized; whether good cultivation has been practised; whether leguminous crops have been grown to any extent; whether the produce raised has been sold, or fed on the land; whether the object of the growth has been for immature produce and for early market, and artificial growth demanded; or whether for maturity, when the natural tendency has simply been assisted and the development normal in all directions.
>
> "That the returns from the use of fertilizers are frequently unprofitable is not always the fault of the fertilizer, and this point may be illustrated by the following typical case: One farmer applies plant-food, his crop is doubled or trebled, and a reasonable profit is secured. Another farmer applies the same amount and kind of fertilizer under similar natural conditions of soil, and he receives no benefit.
>
> "Why then the difference in results? In one case the natural

agencies—sun, air, and water—were assisted and enabled to do their maximum work, while in the other they were prevented from exercising their full influence. Physical conditions of soil were imperfect, due to careless ploughing, seeding, cultivation and cropping.

"In other words, the profit from the use of plant-food is measured to a large degree by the perfection of soil conditions, which are entirely within the power of the farmer to control. The production possible from a definite amount of plant-food can be secured only when the conditions are such as to permit its proper solution, distribution, and retention by the soil.

"The fact that fertilizers may now be easily secured, and the ease of application, have encouraged a careless use rather than a thoughtful expenditure of an equivalent amount of money or energy in the proper preparation of the soil."

While we agree with the author in his view that fertilizers may be of little use to the careless farmer, we must hope that such men are not numerous and are yearly becoming fewer. The question of whether it will pay to use fertilizers is quite as important to the good farmer, and might with advantage have been treated more fully. To such a man it is not a question of using fertilizers or not using them. He recognises that they must be used, and the problem is to what extent they may be used to secure a paying result, and when is that limit reached.

To a certain extent in later chapters the author touches upon this most difficult problem, which really each farmer must answer for himself so greatly does that answer depend upon the soil, the climate, and the value of the crop. Thus, for a special crop like potatoes, it may be necessary and profitable to spend many pounds per acre on fertilizers, whereas for wheat, when prices were low, £1 per acre would be as much as any farmer could spend on fertilizers with advantage, taking one year with another.

The profit which may arise from the use of fertilizers will depend partly on the knowledge shown by the farmer in the purchase of fertilizers, and a very interesting chapter is devoted to this important subject.

The work contains many excellent illustrations of crops, showing the effect of various manures. Any farmer can read and appreciate this book which demands no previous scientific study or knowledge of chemistry. It is a practical work for practical men.

6.—*Continuous Cropping.* By T. WIBBERLEY. London: C. Arthur Pearson. 2s. 6d.

To give a clearer idea of the object of this book it will be well to state that the sub-title runs "Tillage Dairy Farming for small farmers." The author takes as a convenient standard to work by a small holding of 20 acres, and on this holding the main object is to be the production of milk. He thinks milk production wherever possible the ideal system for the small farmer. Among its advantages is "the steady inflow of ready cash resulting from the sale of milk or milk products." In fact, he considers that from every standpoint dairy farming if properly undertaken is very profitable for the small farmer.

Upon this small holding of 20 acres by his system of continuous cropping the author proposes to keep 20 cows. One naturally asks how can it be done. The proposed method is summarised in the following quotations:—

> "A continuous cropping rotation. We may now set down what may be considered as a standard rotation on our twenty-acre holding, and later indicate how the rotation may be modified to suit any abnormal conditions. The rotation is as follows:—
>
> "First year: Tares for soiling. Second year: Tares for hay, followed by winter forage crops. Third year: Roots consisting of mangolds and potatoes. Fourth year: Tares for hay with seeds. Fifth year: Seeds for soiling.
>
> "On a twenty-acre holding cropped on the above lines there would be four acres in each break of the rotation. As will be noted, pasture land has been entirely eliminated, and in its stead four acres of vetches (tares) and four acres of seeds as summer soiling have been substituted. There is a very sound economic reason for this. It requires two acres of good, and three acres of inferior, pasture, for the summer feeding of a dairy cow, whereas one acre of land properly cropped with forage crops will provide enough green food to feed at least three cows throughout the summer.
>
> "In cropping eight acres of land with summer fodder crops, we are, therefore, providing for the feeding of our 20 cows and leaving a surplus over. It is always well to allow a surplus in farming calculations. Dry or unfavourable seasons

may reduce the crop yields, and if a surplus is available it is always possible to turn it into extra fodder for winter feeding.

"For the winter feeding of the farm stock we shall have available the crops produced in the second year's break, consisting of four acres of tare hay, followed by 4 acres of winter forage crops ("winter greens"), 4 acres of roots (say, 2 acres of mangolds and 2 acres of potatoes,) grown in the third year's break, together with 4 acres of tare hay and 4 acres of seeds, hay or ensilage, grown in the fourth year's break. We may tabulate our supply of winter food as follows :—

Break.	Crop.	Area acres.	Yield per acre, Tons.	Total Fodder, Tons.	Total Forage, Tons.
2nd Year	Tares hay ...	4 ...	3½ ...	14 ...	—
	Winter Greens	4 ...	25 ...	— ...	100
3rd Year	Mangolds ...	2 ...	30 ...	— ...	60
	Potatoes ...	2 ...	12 ...	— ...	24
4th Year	Tares ...	4 ...	3½ ...	14 ...	—
	Seeds hay ...	4 ...	2 ...	8 ...	—
	Totals ...	12	producing	36	184

"The above amount of food would be more than is necessary for the feeding of our 20 cows, or their equivalent, during the winter period."

As will have been noticed in the preceding quotation the whole of the summer feeding is to be obtained from 8 acres of land, 4 in tares and 4 in seeds. These, presumably, are to be cut and carried to the cows in the stalls. Would they supply sufficient food?

In his chapter on feeding standards, the author considers a cow of about 10 cwt. requires when yielding 2½ gallons of milk per day, 2·5lbs. of digestible protein and 13·5lbs. starch equivalent. If next we turn to his table of the composition of food we find that 4 stones (56lbs.) of green vetches contain only 1·12lbs. albuminoids, and 4·48lbs. starch value (presumably equivalent), while 4 stones (56lbs.) of rye grass contain ·72lbs. proteins and 6·76 starch value. Adding the two together we get proteins 1·84lbs. starch value 11·24. Even 5 stones of each would only supply 2·3lbs. proteins and 14lbs. of starch equivalent.

This represents a consumption by 20 cows of over 1 ton per day during the summer months. This is rather a large amount of food to obtain from 8 acres, even if the Italian rye grass "would give 3 and sometimes 4 crops in the summer" and the vetches "at least two." The author considers that if "well manured, an

average minimum of 20 tons of green fodder per statute acre can be obtained from these crops."

For the working of this small holding "as manual labourers there are a man and a boy, and a woman to help in the dairy work; and as horse labour a horse and a pony, or better still two strong cobs."

Having explained the implements needed, and how to use them the author takes up one by one the crops to be grown on each break of the rotation starting with tares, which, as will be seen, form the principal crop for this small holding. The making of hay and silage are considered, and then the cultivation of the other crops, "Winter greens," "Potatoes," "Mangolds" and "Seeds."

Such is the main object of this book. Further chapters enter into modifications of the system for larger farms and for mountain farms, and finally there are several chapters on questions of feeding so as to make the best use of the crops grown.

The system of "soiling" which is recommended by the author, and on which, of course, the whole success of his small holding depends, consists of cutting the crop and taking the produce to the cows either in stall or in an adjacent field. This system has been in use in foreign countries for years, but has never yet been largely adopted in this country. It is quite time that farmers studied some of the methods employed by others. One thing is certain, that if such farming can be made profitable, in the sense in which the author uses the word, it will accomplish more than any other system of working a small holding that has yet been tried. The author says:—

> "Let it be understood that in speaking of profitable farming something more is meant than is usually conveyed by such a phrase.
>
> "One cannot regard a small farm as profitable when the owner can only just manage to feed and clothe himself and family and keep clear of debt, or even in addition, save a few pounds in the year.
>
> "Farming, large or small, before it can be termed profitable should at the very least yield a revenue capable not only of providing the necessaries of life for those engaged on the farm, but be profitable enough to yield a reasonable cash wage for every man, woman, and child employed in it, and still leave a surplus as net profit."

To show how such is possible, by intensive cultivation, is the main object of the author in writing this book. He is not a mere theorist, and his book contains many aphorisms which the smallholder might

with advantage learn by heart. Thus "anything that does not pay for feeding certainly won't pay for starving," though applied by the author to young stock, is equally true, not only of every animal on a farm, but of every crop grown, and this is far too frequently overlooked.

One thing the author does not appear to draw attention to, namely, the enormous amount of hard work and constant work which his system would entail. There is no harm in that. While most of us are amused by the tales of work-shy tramps and Weary Willies, we may not recognise that this shyness of work has become of late years far too general for the good of the country. Small holdings will never succeed with those who shirk work.

7.—*The Culture of Profitable Vegetables in Small Gardens.* By SUTTON & SONS. London: Simpkin, Marshall & Co. 6d.

The title of this pamphlet is peculiar; it at once suggested that there were such things as unprofitable vegetables. There being so much talk about the growth of potatoes we at once looked to see what information was given upon the subject. We found a whole page devoted to this crop, and any description more concise yet so full of information we cannot remember having seen.

Further study of this little work of 40 pages proved that it was written by those who thoroughly understood the subject and what were the essential points in cultivation most necessary to draw attention to.

The authors start with general information on methods of digging and trenching, manuring, sowing, and the rotation of crops, giving advice which cannot fail to be of value even to those who have had long experience, while to the novice it will be invaluable.

Subsequently the principal vegetables suitable for small gardens are treated individually.

A calendar showing for each month which vegetables come into use; a most valuable table showing the time to sow or plant, and the right distances for thinning or transplanting, and between the rows; and, finally, a list of prolific varieties suited to small gardens, complete this admirable pamphlet.

In the coming year, doubtless many who have little or no knowledge of gardening will be induced to undertake the growing of vegetables and to such we can heartily recommend this cheap and accurate guide.

8.—*My Growing Garden.* By J. H. McFarland. London: Macmillan & Co. 8s. 6d.

It so happened that the writer of this notice had recently moved into a suburban house having a fairly large so-called garden. The problem of what could be done in his own case to utilise this ground, so as to make it an attractive adjunct to the home without entailing too much expense had given much scope for thought, and this book seemed likely to help solve the problem. The excellent illustrations, some in colour and others in sepia, made one anxious to study the text, so as to find out what the author had to say regarding the production of such ideal beauty.

Then came disappointment. The author had been exceptionally fortunate in finding a plot of ground such as falls to the lot of very few men to discover, and such as rarely exists in the near suburbs of a city. Nevertheless, such spots can be found, especially in more rural districts, but are seldom made so charming as was this garden of the author's which had been growing under his own hand for six years when he set out to describe it.

We had hoped for details, but these were not forthcoming; the author dealt with principles only and left all else to the numerous guides already existing. Still we read on, there being an attraction about the work such as we had seldom, if ever, met with in any work on gardening. What was it that gave this book its peculiar charm? To a certain extent the literary style, notwithstanding this was typically American. There is a freshness about it suggestive of the good air of a garden rather than the stuffiness of a library, Then, gradually, we began to realise what caused this growing garden to differ so essentially from others. The author is evidently an artist, or perhaps it would be more correct to say a photographer with the artist's keen appreciation of colour. Whether in planning out or in planting the garden, there seemed to be ever in his mind one underlying thought, which was that wherever you might stand in the garden and whichever way you might look there should be a view capable of making an artistic picture, satisfactory to the most critical eye as regards colour scheme. How well he succeeded in this is proved by the 36 plates of most excellent reproductions of photographs which admirably demonstrate what can be made of a garden by an artistic gardener. The author thus gives his readers some indication of his aim. "A series of pictures is to be created, and I need to have those pictures relate in colour and season to their surroundings," and again he writes "I

have found that it is easy enough to have the spring and early summer burst of bloom, but not so easy to see to it that some flowers are in sight throughout the summer and the fall."

To those who have gardens large enough to furnish in time "a series of pictures" we think this book will prove of inestimable value. It will afford a new ideal to guide them in adding to the ordinary beauty and utility of a garden something which the author describes as "a true garden individuality all its own."

APPENDIX.

Bath and West and Southern Counties Society.

OBJECTS OF THE SOCIETY AND PRIVILEGES OF MEMBERSHIP.

ANNUAL EXHIBITIONS.

The Society annually holds an Exhibition in some city or town in England or Wales. Each section of the Society's district is visited at intervals, so that most Members have an opportunity of seeing the Show in their own neighbourhood every few years. Prizes to a large amount are given for Horses, Cattle, Sheep, Pigs, Farm Produce, &c. Provision is also made for the exhibition of Agricultural Implements and Machinery, Seeds, Cattle Foods, Artificial Manures, and articles of general utility. A substantially built and completely equipped Working Dairy on a large scale is a special feature of these Exhibitions. Here explanatory demonstrations and comparative tests of implements and processes are carried on, with the assistance of well-known practical and scientific experts, and Butter-making Competitions are held. Among the features of the Annual Meeting are Shoeing, Milking and other Competitions, Poultry and Horticultural Shows, and Exhibitions illustrative of Bee-keeping, Home Industries, Art-Manufactures, Nature Study and Forestry.

Membership entitles to free admission to the Annual Exhibition, and also to the Grand Stand overlooking the Horse and Cattle Ring, to the Reserved Seats in the Working Dairy, and to the use of the Members' Special Pavilion for Luncheons, Reading, Writing, &c.

Entries can be made by Members (elected on or before the last Tuesday in January preceding the Show) at half the Fees payable by Non-Members.

THE JOURNAL.

All Members receive free of charge the Society's Journal, which is published annually bound in cloth. It has for its aim the dissemination of agricultural knowledge in a popular form, and, in addition to original articles by well-known agricultural authorities, it contains particulars of the Society's general operations, full reports of its experimental and research work, prize awards, financial statements, lists of Members, reviews of new books on agriculture, &c. (The price of the *Journal* to non-Members is 6s. 5d. post free.)

CHEMICAL AND OTHER FACILITIES.

The Society has a Consulting Chemist *from whom Members can obtain analyses and reports at reduced rates of charge.* An arrangement has also been made under which Members of the Society can obtain, free of charge, from the National Fruit and Cider Institute at Long Ashton, analyses of cider-apples and perry-pears, and, with a view to assisting farmers and others in dealing with insect and other pests which affect agriculture, horticulture, &c., the Council have availed themselves of an offer from the Board of Economic Biology of the University of Bristol to investigate the nature of any insect or other pest and report upon it free of charge.

EXPERIMENTS.

Experiments on crops are conducted at experimental stations in various parts of the Kingdom, and *Members are enabled to take part in these and to receive reports thereon*.

ART-MANUFACTURES, NATURE STUDY, FORESTRY, &c.

One of the objects for which the Society was founded was the encouragement of Arts as well as Agriculture, and, to this end, exhibitions are held of Art-Manufactures and of work representative of Arts and Handicrafts. Exhibitions are also held illustrating Nature Study, as a branch of Education; the Science of Forestry, &c.

TERMS OF MEMBERSHIP.

ANNUAL SUBSCRIPTIONS.

Governors, not less than	£2
Ordinary Members, not less than	£1
Tenant Farmers, the rateable value of whose holdings does not exceed £200 a-year, not less than	10s.

Governors, who are eligible for election as President or Vice-President, are entitled, in addition to the privileges already mentioned, to an extra Season Ticket for the Annual Exhibition and for the Grand Stand, &c. Governors subscribing more than £2 are entitled to a further Ticket for every additional £1 subscribed.

Members subscribing less than £1 are entitled to all the privileges of Membership except that of entering Stock at reduced fees, and their admission Ticket for the Annual Show is available for *one day only* instead of for the whole time of the Exhibition.

LIFE COMPOSITIONS.

Governors may compound for their Subscription for future years by payment in advance, of £20; and Members by payment, in advance, of £10. Governors and Members who have subscribed for twenty years may become Life Members on payment of half these amounts.

Any person desirous of joining the Society can be proposed by a Member, or by

THOS. F. PLOWMAN,
Secretary and Editor,

3, Pierrepont Street, Bath.

Telegraphic Address—"PLOWMAN, BATH."

Telephone No. 610.

Bath and West and Southern Counties Society.

GENERAL LAWS.

As revised in accordance with the Report of a Special Committee; which Report was received and adopted by the Annual General Meeting of Members, held on May 30, 1895.

COMPOSITION OF THE SOCIETY.

I. The Society shall consist of a President, Vice-Presidents, Trustees, Council, Treasurer, Secretary, and Members.

OBJECTS.

II. The Society shall have the following objects :—

a. To hold Exhibitions of breeding stock, agricultural implements, and such other articles connected with agriculture, arts, manufactures or commerce, as may be determined upon by the Council.

b. To conduct practical and scientific investigations in agriculture.

c. To promote technical education in agriculture by providing means of systematic instruction.

d. To publish a Journal for circulation.

SUBSCRIPTIONS.

III. The Annual Subscription for Members shall be as follows :—

Governors (who are eligible for election as President or Vice-President), not less than	£2
Ordinary Members, not less than	£1
Tenant Farmers (the rateable value of whose holdings does not exceed £200 a-year), not less than	10*s.*

IV. The payment of £20 in one sum shall constitute a Governor for life, and of £10 in one sum an Ordinary Member for life ; but any Governor who has subscribed not less than £2 annually for a period of twenty years may become a Life Governor on the further payment of £10 in one sum ; and any Ordinary Member, who has subscribed not less than £1 annually for the same period may become a Life-Member on the further payment of £5 in one sum.

V. Subscriptions shall become due and be payable in advance on the 1st of January in each year or as soon as the Subscriber has been elected a Member. When the election takes place during the last quarter of the year the subscription payable on election will be considered as applying to the ensuing year.

VI. A Member shall be liable to pay his subscription for the current year unless he shall have given notice, in writing, to the Secretary before January 1st of his intention to withdraw.

GOVERNING BODY.

VII. The entire management of the Society—including the making of Bye-laws, election of Members, determining the Prizes to be awarded, appointing Committees, fixing the Places of Meetings and Exhibitions, appointing or removing the Treasurer, Secretary, and such other officers as may be required to carry on the business of the Society—shall be vested in the Council, who shall report its proceedings at the Annual Meetings of the Society.

VIII. The Council shall consist of the Patron (if any), President, Vice-Presidents, Trustees, and Treasurer (who shall be *ex-officio* Members), and of sixty-six elected Members.

ELECTION OF PRESIDENT, VICE-PRESIDENTS, TRUSTEES, AND COUNCIL.

IX. The election of a President for the year, of any additional Vice-Presidents or Trustees, and of the Members of Council representing the Divisions named in Law X., shall take place at the Annual Meeting of the Society, and they shall enter into office at the conclusion of the Exhibition during which such Annual Meeting has been held.

X. The sixty-six Members of the Council referred to in Laws VIII. and IX. shall consist of fifty-eight persons residing or representing property in the following Divisions, viz. :—

Twelve from the Counties of Devon and Cornwall, which shall be called the Western Division;

Twenty-four from the Counties of Somerset, Dorset, and Wilts, which shall be called the Central Division;

Twelve from the Counties of Hants, Berks, Oxon, Bucks, Middlesex, Surrey, Sussex, and Kent, which shall be called the Southern Division; and

Ten from the Counties of Worcester, Gloucester, Hereford and Monmouth, and the Principality of Wales, which shall be called the North-Western Division.

The remaining eight shall be elected (irrespective of locality) from the general body of members, and shall form a Division which shall be called the "Without Reference to District" Division.

XI. One-half of the elected Members in each of the five Divisions named in Law X. shall retire annually by rotation, but shall be eligible for re-election.

XII. The Council shall have power to nominate a President, Vice-Presidents, Trustees, and Members of Council for the approval of the Annual Meeting, and to fill up such vacancies in their own body as are left after the Annual Meeting, or as may from time to time occur during the interval between the Annual Meetings.

XIII. Nominations to offices, election to which is vested in the whole body of Members, must reach the Secretary ten days before the meeting at which such vacancies are to be filled up.

MEETINGS.

XIV. The Annual Meeting of the Society shall take place during the holding of the annual Exhibition.

XV. Special General Meetings of the Society may be convened by the President on the written requisition of not less than three Members of Council; and all Members shall have ten days' notice of the object for which they are called together.

XVI. No Member of less than three months' standing, or whose subscription is in arrear, shall be entitled to vote at a Meeting.

EXHIBITIONS.

XVII. The Annual Exhibitions of the Society shall be held in different Cities or Towns in successive years.

XVIII. All Exhibitors shall pay such fees as may be fixed by the Council. Members subscribing not less than £1 per annum, who have been elected previous to February 1st, and have paid the subscription for the current year, shall be entitled to exhibit at such reduction in these fees as the Council shall determine.

PRIZES.

XIX. All prizes offered at the cost of the Society shall be open for competition to the United Kingdom.

XX. No person intending to compete for any prize offered at the annual Exhibition shall be eligible to act as a judge or to have any voice in the selection of judges to award the premiums in the department in which he exhibits.

XXI. If it be proved to the satisfaction of the Council that any person has attempted to gain a prize in this, or in any other society, by a false certificate or by a misrepresentation of any kind, such person shall thereupon be, for the future, excluded from exhibiting in this Society.

JOURNAL.

XXII. The Proceedings of the Society, Awards of Prizes, Financial Statements and Lists of Officers, Governors, and Members, shall be printed annually in the Society's *Journal*, and every Governor and Member, not in arrear with his subscription, shall be entitled to receive one copy, free of expense, and there shall be an additional number printed for sale.

POLITICS.

XXIII. No subject or question of a political tendency shall be introduced at any Meeting of this Society.

ALTERATIONS IN LAWS.

XXIV. No new General Law shall be made or existing one altered, added to or rescinded, except at an Annual or Special General Meeting, and then only provided that a statement of particulars, in writing, shall have been sent to the Secretary at least twenty-one days previous to the Meeting at which the question is to be considered.

List of Officers,

1916-1917.

PATRON.

HIS MOST GRACIOUS MAJESTY THE KING.

PRESIDENT.

THE RIGHT HON. THE EARL OF COVENTRY.

TRUSTEES.

*BATH, THE MARQUIS OF, Longleat, Warminster.
ACLAND, SIR C. T. D., BART., Killerton, Exeter.
EDWARDS, C. L. F., The Court, Axbridge, Somerset.

VICE-PRESIDENTS.

ACLAND, SIR C. T. D., Bart.	Killerton, Exeter
ALLEN, J. D.	Springfield House, Shepton Mallet
BADCOCK, H. J.	Broadlands, Taunton
BAKER, G. E. LLOYD	Hardwicke Court, Gloucester
*BATH, MARQUIS OF	Longleat, Warminster
*BEAUFORT, DUKE OF	Badminton, Chippenham
BENYON, J. HERBERT	Englefield House, Reading
*BUTE, THE MARQUIS OF	The Castle, Cardiff
*CLINTON, LORD	Heanton Satchville, Dolton, N. Devon
DEVONSHIRE, DUKE OF	Chatsworth, Derbyshire
*DIGBY, LORD	Minterne, Cerne Abbas
*DUCIE, EARL OF	Tortworth, Falfield, R.S.O.
EDWARDS, C. L. F.	The Court, Axbridge, Somerset
*FALMOUTH, VISCOUNT	Tregothnan, Truro
FITZHARDINGE, LORD	Cranford, Hounslow
HAMBLEDEN, VISCOUNT	Greenlands, Henley-on-Thames
HOBHOUSE, RIGHT HON. H.	Hadspen House, Castle Cary
*LANSDOWNE, MARQUIS OF, K.G.	Bowood, Calne
*LLEWELYN, SIR J. T. D., Bart.	Penllergaer, Swansea
MORETON, LORD	Sarsden House, Chipping Norton
*MOUNT-EDGCUMBE, EARL OF	Mount Edgcumbe, Devonport
NEVILLE-GRENVILLE, R.	Butleigh Court, Glastonbury
NORTHUMBERLAND, DUKE OF	Albury Park, Guildford
*PLYMOUTH, EARL OF	Hewell Grange, Bromsgrove

*** Those to whose names an asterisk (*) is prefixed have filled the office of President.

VICE-PRESIDENTS—*continued.*

POLTIMORE, LORD	Poltimore Park, Exeter
*PORTMAN, VISCOUNT	Bryanston, Blandford
*RADNOR, EARL OF	Longford Castle, Salisbury
SHELLEY, SIR J., Bart. . . .	Shobrooke Park, Crediton
SOMERSET, DUKE OF	Maiden Bradley, Bath
STRACHIE, LORD	Sutton Court, Pensford, Somerset
TEMPLE, EARL	Newton St. Loe, Bristol
WALDRAN, LORD	Bradfield, Cullompton

THE LORD WARDEN OF THE STANNARIES.

THE SECRETARY AND KEEPER OF THE RECORDS OF THE DUCHY OF CORNWALL.

THE RECEIVER-GENERAL OF THE DUCHY OF CORNWALL.

*** Those to whose names an asterisk (*) is prefixed have filled the office of President.

MEMBERS OF COUNCIL.

EX-OFFICIO MEMBERS.

THE PATRON.	THE VICE-PRESIDENTS.
THE PRESIDENT	THE TRUSTEES.
	THE TREASURER.

ELECTED MEMBERS.

WESTERN DIVISION (DEVON AND CORNWALL).

(12 *Representatives.*)

Elected in 1915.

Name.	*Address.*
BOSCAWEN, REV. A. T.	Ludgvan Rectory, Long Rock, R.S.O., Cornwall
DAW, J. E.	Exeter
LEVERTON, W.	Woolleigh Barton, Beaford, N. Devon
LOPES, SIR HENRY Y. B., Bart.	Maristow, Roborough, S. Devon
MARTYN G.	Liskeard, Cornwall
SILLIFANT, A. O.	Culm Leigh, Stoke Canon, Exeter

Elected in 1916.

Name.	*Address.*
BAYLY, J.	Highlands, Ivy Bridge, S. Devon
BUCKINGHAM, REV. PREB.	The Rectory, Doddiscombsleigh, Exeter
GIBBS, A. H.	Pytte, Clyst St. George, Topsham, Devon
MOORE-STEVENS, COL. R. A.	Winscott, Torrington, Devon
SHELLEY, J. F.	Posbury House, Crediton
STUDDY, T. E.	Mazonet, Stoke Gabriel, Totnes

CENTRAL DIVISION (SOMERSET, DORSET, AND WILTS).

(24 *Representatives.*)

CLARK, W. H.	Rutland Cottage, Combe Down, Bath
FARWELL, E. W.	Queen's Parade, Bath
GORDON, G. H.	The Barn House, Sherborne, Dorset
HILL, V. T.	Mendip Lodge, Langford, Bristol
HOARE, SIR H. H. A., Bart.	Stourhead, Zeals, S.O., Wilts
HURLE, J. C.	Brislington Hill, Bristol
KNIGHT, S. J.	Walnut Farm, East Dundry, Bristol
RAWLENCE, E. A.	Newlands, Salisbury
RAWLENCE, G. N.	7, Moberley Road, Salisbury
SOMERVILLE, A. F.	Dinder House, Wells
WATSON, HON. T. H.	Cormiston, Milverton, Somt.
WHITE, A. R.	Charnage, Mere, Wilts
FOX, R. A.	Yate House, Yate, Glos.
GIBSON, J. T.	Claverham, Yatton
MAULE, M. ST. J.	Chapel House, Bath
NAPIER, H. B.	Long Ashton, Clifton, Bristol
NICHOLS, G.	49, Broad Street, Bristol
PARRY-OKEDEN, LT.-COL. U. E. P.	Turnworth, Blandford, Dorset
SANDERS, R. A., M.P.	Barwick House, Yeovil
TUDWAY, C. C.	The Cedars, Wells, Somt.
WYNFORD, LORD	Warmwell, Dorchester

SOUTHERN DIVISION (HANTS, BERKS, OXON, BUCKS, MIDDLESEX, SURREY, SUSSEX AND KENT).

(12 *Representatives.*)

ASHCROFT, W.	13, The Waldrons, Croydon
BURRELL, SIR M. R., Bart.	Knepp Castle, Horsham, Sussex
COBB, H. M.	Higham, Kent
CUNDALL, H. M., I.S.O., F.S.A.	4, Marchmont Gardens, Richmond, Surrey
DRUMMOND, H. W.	Board Room L.& S.W.R., Waterloo Stn., London.
LLEWELLYN, L. T. E.	Hackwood, Basingstoke
BEST, MAJOR T. G.	East Carleton Manor, Norwich
BYNG, COL. HON. C.	70, Ashley Gardens, London, S.W.
JERVOISE, F. H. T.	Herriard Park, Basingstoke
LATHAM, T.	Dorchester, Oxon
RUTHERFORD, J. A.	Highclere Estate Office, Newbury
SUTTON, E. P. F.	Sidmouth Grange, nr. Reading

NORTH-WESTERN DIVISION (WORCESTERSHIRE, GLOUCESTERSHIRE, HEREFORDSHIRE, MONMOUTHSHIRE AND WALES).

(10 *Representatives.*)

ACKERS, C. P.	Huntley Manor, Gloucester
ALEXANDER, D.	Cardiff
ALEXANDER, H. G.	5, High Street, Cardiff
BATHURST, C., M.P.	Lydney Park, Gloucester
DRUMMOND, Col. F. D. W.	Cawdor Estate Office, Carmarthen
ALLSEBROOK, A	Link Elm, Malvern Link
BEST, CAPT. W.	Vivod, Llangollen
COTTERELL, SIR J., Bart.	Garnons, Hereford
LIPSCOMB, G.	Margam Park Estate Office, Port Talbot
MASON, F. F.	Swansea

WITHOUT REFERENCE TO DISTRICT DIVISION.

(8 *Representatives.*)

EVANS, H. M. G.	Plassissa, Llangennech, Carmarthen
LEWIS, COL. H.	Green Meadow, near Cardiff
WILLIAMS, JESTYN	Llanover Estate, Newport, Mon.
ACLAND, Rt. Hon. F. DYKE	93, Bedford Gardens, Campden Hill, London, W.
KNOLLYS, C. R.	Weekley, Kettering
PORTMAN, HON. C. B.	Goldicote, Stratford-on-Avon
WILLIAMS, JOHN	Scorrier House, Scorrier, Cornwall

STANDING COMMITTEES, 1916-1917.

[The PRESIDENT is an *ex-officio* Member of all Committees.]

ALLOTMENT.

EDWARDS, C. L. F., *Chairman.*

BATH, MARQUIS OF
BEST, CAPT. W.
BYNG, COL. HON. C.
MASON, F. F.
NAPIER, H. B.
STUDDY, T. E.
WYNFORD, LORD

CONTRACTS.

NAPIER, H. B., *Chairman.*

ALLSEBROOK, A.
BATH, MARQUIS OF
BEST, CAPT. W.
DAW, J. E.
EDWARDS, C. L. F.
MASON, F. F.
NEVILLE-GRENVILLE, R.
RAWLENCE, G. N.
STUDDY, T. E.

DAIRY.

ACLAND, SIR C. T. D., Bart., *Chairman.*

SOMERVILLE, A. F., *Vice-Chairman.*

ALLEN, J. D.
ASHCROFT, W.
BOSCAWEN, REV. A. T.
CLARK, W. H.
GIBSON, J. T.
HURLE, J. COOKE
KNIGHT S. J.
LATHAM, T.
LLEWELLYN, L. T. E.
NAPIER, H. B.
NEVILLE-GRENVILLE, R.
STRACHIE LORD
TUDWAY, C. C.

DISQUALIFYING.

THE STEWARDS OF LIVE STOCK AND PRODUCE.

EXPERIMENTS AND EDUCATION.

ACLAND, SIR C. T. D., Bart., *Chairman.*

ALLEN, J. D.
ASHCROFT, W.
BAKER, G. E. LLOYD
BATHURST, C., M.P.
BENYON, J. H.
GIBSON, J. T.
HOBHOUSE, RT. Hon. H.
HURLE, J. COOKE
LATHAM, T.
NEVILLE-GRENVILLE, R.
RAWLENCE, E. A.
RUTHERFORD, J. A.
SOMERVILLE, A. F.

(With power to add to their number.)

FINANCE.

NAPIER, H. B., *Chairman.*

DAW, J. E.
GIBBS, A. H.

FORESTRY.

LIPSCOMB, G., *Chairman.*

ACKERS, C. P.
ACLAND, SIR C. T. D., Bart.
CLINTON, LORD
DRUMMOND, COL. F. D. W.
DUCHESNE. M. C.
EVANS, H. M. G.
HOARE, SIR H. H. A. Bart.
NAPIER, H. B.
NORTH, G. F.
RUTHERFORD, J. A.

IMPLEMENT REGULATIONS.

SHELLEY, SIR J., Bart., *Chairman.*

ACLAND, SIR C. T. D., Bart.
BATH, MARQUIS OF
BEST, CAPT. W.
EDWARDS, C. L. F.
MARTYN, G.
MASON, F. F.
MOORE-STEVENS, COL. R. A.
NAPIER, H. B.
NEVILLE-GRENVILLE, R.
STUDDY, T. E.

JOURNAL.

ACLAND, Sir C. T. D., Bart., *Chairman.*

BAKER, G. E. LLOYD
BATHURST C., M.P.
HOBHOUSE, RIGHT HON. H.

JUDGES' SELECTION.

SILLIFANT, A. O., *Chairman.*

ALEXANDER, D.
ALEXANDER, H. G.
ALLEN, J. D.
ASHCROFT, W.
BYNG, COL. HON. C.
GORDON, G.
HOARE SIR H. H. A., Bart.
LATHAM, T.
MOORE-STEVENS, COL. R. A.
PARRY-OKEDEN, LIEUT.-COL. U. E. P.
SHELLEY, SIR J., Bart.
WYNFORD, LORD

RAILWAY ARRANGEMENTS AND ADVERTISEMENTS.

ALEXANDER, D.
COVENTRY, EARL OF
DRUMMOND, H. W.
MASON, F. F.
SHELLEY SIR J., Bart.

(With power to add to their number.)

SCIENCE AND ART.

BATH, MARQUIS OF, *Chairman.*

ACLAND, SIR C. T. D., Bart.
CUNDALL, H. M. (I.S.O., F.S.A.)
DAW, J. E.
EVANS, H. M. G.
FARWELL, E. W.
HOBHOUSE, RT. HON. H.
LEGARD, A. G.
LIPSCOMB, G.
LLEWELYN, SIR J. T. D., Bart.
NAPIER, H. B.
RUTHERFORD, J. A.

(With power to add to their number.)

SELECTION.

THE CHAIRMEN OF ALL OTHER COMMITTEES.

SHOW PLACE AND DATE.

CHAIRMEN OF THE ALLOTMENT, CONTRACTS, DAIRY, FINANCE, FORESTRY, IMPLEMENT REGULATIONS, RAILWAY ARRANGEMENTS, SCIENCE AND ART, AND STOCK PRIZE SHEET COMMITTEES.

(With power to add two Local Members to their number.)

STOCK PRIZE SHEET.

SILLIFANT, A. O., *Chairman.*

ALEXANDER, D.
ALEXANDER, H. G.
ALLEN, J. D.
ALLSEBROOK, A.
ASHCROFT, W.
BUCKINGHAM, REV. PREB.
BYNG, COL. HON. C.
CLARK, W. H.
COTTERELL, SIR J., Bart.
EVANS, H. M. G.
HOARE, SIR H. H. A., Bart.
LATHAM, T.
LEVERTON, W.
MOORE-STEVENS, COL. R. A.
PORTMAN, HON. C. B.
SHELLEY, SIR J. Bart.
SUTTON, E. P. F.
WHITE, A. R.
WILLIAMS, JESTYN
WYNFORD, LORD

WORKS.

EDWARDS, C. L. F., *Chairman.*

BATH, MARQUIS OF
BEST, CAPT. W.
NAPIER, H. B.
STUDDY, T. E.

Stewards.

Cattle, Sheep and Pigs.

BYNG, COL. HON. C.
ASHCROFT, W.
MOORE-STEVENS, COL. R. A.

Cider.

FARWELL, E. W.

Dairy.

SOMERVILLE, A. F.

Experiments.

ASHCROFT, W.

Finance.

NAPIER, H. B. GIBBS, A. H.
DAW, J. E.

Forestry.

LIPSCOMB, G.

Horses.

ALEXANDER, D.
WYNFORD, LORD

Horticulture.

BOSCAWEN, REV. A. T.

Poultry.

STUDDY, T. E.

Science and Art and Music.

CUNDALL, H. M. (I.S.O., F.S.A.)

Shoeing.

LATHAM, T.

Yard.

EDWARDS, C. L. F.
BEST, CAPT. W.
BATH, MARQUIS OF
STUDDY, T. E.

Other Honorary Officials.

Treasurer—LUTTRELL, C. M. F.

Chaplain.

BOSCAWEN, REV. A. T.

Permanent Officials.

Secretary and Editor—PLOWMAN, THOMAS F.

Associate Editor.

LLOYD, F. J. (F.C.S.)

Auditor.

GOODMAN, F. C. (*Chartered Accountant*)

Consulting Chemist.

VOELCKER, DR. J. A. (M.A., F.I.C.)

Veterinary Inspector.

PENBERTHY, Prof. J. (F.R.C.V.S.)

Superintendent of Works.

AYRE, H. C.

Annual Exhibitions.

Year.	Place Visited.	Local Subscription.	Prizes. Local Committee.	Prizes. Local Societies	Prizes. Local Residents.	Total Local Contribution.	President.	Admissions. On 2/6 Days.	Admissions. On 1/- Days.	Admissions. Total.
		£	£	£	£	£				
1852	Taunton	210	..	..	..	210	Lord Portman	..	..	..
1853	Plymouth	450	..	..	..	450	Sir T. D. Acland, Bart.	..	..	..
1854	Bath	450	..	..	..	450	William Miles, M.P.	..	..	..
1855	Tiverton	450	..	..	..	450	Earl Fortescue	..	..	..
1856	Yeovil	450	..	..	..	450	C. A. Moody, M.P.	..	..	..
1857	Newton Abbot	700	..	..	..	700	Lord Courtenay	..	..	..
1858	Cardiff	800	..	..	..	800	Lord Courtenay	..	..	..
1859	Barnstaple	800	85	..	81	966	John Sillifant	..	..	..
1860	Dorchester	900	..	..	..	900	Lord Rivers	10,709	11,949	22,658
1861	Truro	900	..	..	..	900	J. W. Buller, M.P.	15,201	14,220	29,421
1862	Wells	900	..	..	..	900	Sir T. D. Acland, Bart.	10,578	4,775	15,353
1863	Exeter	900	..	..	..	900	Marquis of Bath	15,635	19,284	34,919
1864	Bristol	1000	106	..	50	1156	Earl Fortescue	22,377	65,678	88,055
1865	Hereford	900	358	..	..	1258	Lord Taunton	16,575	35,261	51,836
1866	Salisbury	900 }	57	..	..	957	{ Earl of Portsmouth	7,288	18,737	26,025
1867	Salisbury	.. }					{ J. Tremayne	7,502	16,702	24,204
1868	Falmouth	900	..	..	..	900	Sir J. T. B. Duckworth, Bart.	11,393	19,495	30,888
1869	Southampton	900	132	..	18	1050	Earl of Carnarvon	15,340	41,290	56,630
1870	Taunton	900	..	..	..	900	Sir S. H. Northcote, Bart., C.B., M.P.	17,952	33,653	51,605
1871	Guildford	900	110	..	..	1010	Earl of Cork	10,656	23,406	34,062
1872	Dorchester	800	..	..	10	810	Duke of Marlborough, K.G.	12,791	21,517	34,308
1873	Plymouth	800	..	400	..	1200	Earl of Mount-Edgcumbe	16,665	45,744	62,409
1874	Bristol	800	403	..	..	1203	Sir Massey Lopes, Bart., M.P.	37,329	72,791	110,120
1875	Croydon	800	245	..	..	1045	R. Benyon, M.P.	14,518	26,028	40,546
1876	Hereford	800	381	..	..	1181	Earl of Ducie	16,396	32,645	49,041
1877	Bath	800	215	..	..	1015	Marquis of Lansdowne	27,625	48,852	76,477
1878	Oxford	800	..	170	6	976	Earl of Jersey	12,414	26,995	39,409

ANNUAL EXHIBITIONS—*continued.*

Year.	Place Visited.	Local Subscription.	Prizes. Local Committee.	Prizes. Local Societies	Prizes. Local Residents.	Total Local Contribution.	President.	Admissions. On 5/- Day.	Admissions. On 2/6 Days.	Admissions. On 1/- Days.	Admissions. Total.
		£	£	£	£	£					
1879	Exeter	800	..	..	10	810	Earl of Morley	..	14,634	40,533	55,167
1880	Worcester	800	..	254	..	1054	Earl of Coventry	..	8,415	37,675	46,090
1881	Tunbridge Wells	800	245	34	..	1079	Marquis of Abergavenny	..	13,368	33,236	46,604
1882	Cardiff	800	200	198	17	1215	Lord Tredegar	..	23,941	38,680	62,621
1883	Bridgwater	800	78	..	..	878	Lord Brooke, M.P.	..	17,171	31,241	48,412
1884	Maidstone	800	310	33	75	1218	Viscount Holmesdale	..	13,501	31,053	44,554
1885	Brighton	800	227	33	82	1142	Viscount Hampden	..	9,637	39,851	49,488
1886	Bristol	800	525	..	..	1325	Lord Carlingford	..	29,580	70,999	100,579
1887	Dorchester	800	..	112	..	912	Earl of Ilchester	..	8,860	29,846	38,706
1888	Newport (Mon.)	800	100	..	..	900	Lord Tredegar	..	14,878	38,567	53,445
1889	Exeter	800	..	..	10	810	Lord Clinton	..	16,405	36,195	52,600
1890	Rochester	800	294	..	26	1120	Earl of Darnley	..	3,480	48,314	51,794
1891	Bath	800	50	103	100	1053	Earl Temple	..	23,510	52,185	75,695
1892	Swansea	800	200	100	10	1110	Sir J. D. T. Llewelyn, Bart.	..	18,364	54,609	72,973
1893	Gloucester	800	400	..	..	1200	Lord Fitzhardinge	..	14,272	40,368	54,640
1894	Guildford	800	174	..	10	984	Earl of Onslow	..	8,671	29,813	38,484
1895	Taunton	800	85	160	10	1055	Viscount Portman	..	13,181	30,111	43,292
1896	St. Albans	800	152	..	..	952	Earl of Clarendon	..	12,056	22,380	34,436
1897	Southampton	800	50	..	..	850	Lord Montagu of Beaulieu	..	8,284	33,750	42,034
1898	Cardiff	800	200	..	..	1000	Lord Windsor	..	13,101	42,501	55,602
1899	Exeter	800	..	225	5	1030	Lord Clinton	..	16,091	39,832	55,923
1900	Bath	800	100	150	10	1060	Marquis of Bath	954	11,601	36,814	49,369
1901	Croydon	800	115	..	..	915	H.R.H. The Duke of Cornwall and York, K.G.	1,196	9,362	30,693	41,251
1902	Plymouth	800	105	100	36	1041	Earl of Morley	842	12,629	40,565	54,036
1903	Bristol	800	434	50	61	1345	Duke of Beaufort	..	34,528	74,352	108,880
1904	Swansea	800	350	..	..	1150	Lord Windsor	..	28,265	50,562	78.827

Annual Exhibitions—*continued.*

Year.	Place Visited.	Local Subscription.	Prizes.			Total Local Contribution.	President.	Admissions.			
			Local Committee.	Local Societies.	Local Residents.			On 5/- Day.	On 2/6 Days.	On 1/- Days.	Total.
		£	£	£	£	£					
1905	Nottingham	800	..	218	..	1018	Duke of Portland, K.G.	..	8,913	45,964	54,877
1906	Swindon	800	..	200	50	1050	Earl of Radnor	..	7,838	42,013	49,851
1907	Newport (Mon.)	800	201	51	29	1081	H.R.H. The Prince of Wales, K.G.	..	16,236	37,819	54,055
1908	Dorchester	800	100	25	..	925	Lord Digby	..	12,227	20,350	32,577
1909	Exeter	800	..	100	..	900	Lord Clinton	..	14,898	41,891	56,789
1910	Rochester and Chatham	800	117	..	..	917	Earl of Darnley	..	5,892	20,105	25,997
1911	Cardiff	800	195	110	10	1115	Marquis of Bute	..	16,213	40,588	56,801
1912	Bath	800	100	100	..	1000	Marquis of Bath	..	13,843	40,935	54,788
1913	Truro	800	35	115	39	918	Viscount Falmouth	..	12,918	44,700	57,618
1914	Swansea	800	301	..	..	1101	Sir J. T. D. Llewelyn, Bart.	..	17,957	67,805	85,762
1915	Worcester	400	..	257	..	657	The Earl of Coventry	..	7,760	28,013	35,773
1916	No Show.						The Earl of Coventry				

Members' Privileges.

ANALYSES OF FERTILISERS, FEEDING STUFFS, WATERS, SOILS, &c.

Applicable only to the case of Persons who are not commercially engaged in the manufacture or sale of any substance sent for Analysis).

Members of the Bath and West and Southern Counties Society, who may also be Members of other Agricultural Societies, are particularly requested in applying for Analyses, to state that they do so as Members of the first-named Society.

THE following are the rates of Charges for Chemical Analyses to Members of the Society.

These privileges are applicable only when the analyses are for *bona-fide* agricultural purposes, and are required by Members of the Society for their own use and guidance in respect of farms or land in their own occupation and within the United Kingdom

The analyses are given on the understanding that they are required for the individual and sole benefit of the Member applying for them, and must not be used for other persons, or for commercial purposes.

Land or estate agents, bailiffs, and others, when forwarding samples are required to state the names of those Members on whose behalf they apply.

Members are also allowed to send for analysis under these privileges any manures or feeding-stuffs to be used by their outgoing tenants, or which are to be given free of cost to their occupying tenants.

The analyses and reports may not be communicated to either vendor or manufacturer, except in cases of dispute.

Members are requested, when applying for an analysis, to quote the number in the subjoined schedule under which they wish it to be made.

No.		
1.	—An opinion of the purity of bone-dust or oil-cake (each sample)	2*s.* 6*d.*
2.	—An analysis of sulphate or muriate of ammonia, or of nitrate of soda, together with an opinion as to whether it be worth the price charged	5*s.*
3.	—An analysis of guano, showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts and ammonia, together with an opinion as to whether it be worth the price charged	10*s.*
4.	—An analysis of mineral superphosphate of lime for soluble phosphates only, together with an opinion as to whether it be worth the price charged	5*s.*
5.	—An analysis of superphosphate of lime, dissolved bones, &c., showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia, together with an opinion as to whether it be worth the price charged	10*s.*
6.	—An analysis of bone-dust, basic slag, or any other ordinary artificial manure, together with an opinion as to whether it be worth the price charged	10*s.*
7.	—An analysis of compound artificial manures, animal products, refuse substances used for manure, &c.	from 10*s.* to £1
8.	—An analysis of limestone, showing the proportion of lime	7*s.* 6*d.*
9.	—An analysis of limestone, showing the proportion of lime and magnesia ..	10*s.*
10.	—An analysis of limestone or marls, showing the proportion of carbonate, phosphate, and sulphate of lime and magnesia, with sand and clay	10*s.*
11.	—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime	£1
12.	—Complete analysis of a soil	£3
13.	—An analysis of oil-cake or other substance used for feeding purposes, showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre as well as of starch, gum, and sugar in the aggregate; and an opinion of its feeding and fattening or milk-producing properties..	10*s.*
14.	—Analysis of any vegetable product	10*s.*
15.	—Determination of the "hardness" of a sample of water before and after boiling	5*s.*
16.	—Analysis of water of land-drainage, and of water used for irrigation	£1
17.	—Analysis of water used for domestic purposes	£1 10*s.*
18.	—An analysis of milk (to assist Members in the management of their Dairies and Herds, *bona-fide* for their own information and not for trade purposes, nor for use in connection with the Sale of Food and Drugs Acts)	5*s.*
19.	—Personal consultation with the Consulting Chemist. (To prevent disappointment it is suggested that Members desiring to hold a consultation with the Consulting Chemist should write to make an appointment)	5*s.*
20.	—Consultation by letter	5*s.*
21.	—Consultation necessitating the writing of three or more letters	10*s.*

Members wishing to exercise their privileges on the above-named terms, should forward their samples for examination *by post or parcel prepaid*, to the Consulting Chemist, DR. JOHN AUGUSTUS VOELCKER, M.A., F.I.C., Stuart House, 1, Tudor Street, London, E.C.

The fees for analysis must be sent to the Consulting Chemist at the time of application.

GUIDE TO PURCHASERS OF FERTILISERS AND FEEDING STUFFS.

Purchasers are recommended in every case to insist upon having an *Invoice* given to them. This invoice should set out clearly :—

In the case of **Fertilisers**—

(1.) the **name** of the fertiliser ;

(2.) whether the fertiliser be artificially **compounded** or not ;

(3.) the **analysis** guaranteed in respect of the principal fertilising ingredients.

In the case of **Feeding-Stuffs**—

(1.) the **name** of the article ;

(2.) the **description** of the article ; whether it has been made from one substance or seed only, or from more than one

(3.) the **analysis** guaranteed in respect of Oil and Albuminoids.

(NOTE.—The use of the terms "Linseed-cake," "Cotton-cake," &c., implies that these cakes shall be "pure," and purchasers are recommended to insist upon these terms being used without any qualification such as "95 per cent.," "as imported," &c. "Oil-cake" should be avoided.

Members of the Society should see that the **Invoices** agree accurately with the orders given by them, and, in giving these orders, they should stipulate that the goods come up to the guarantees set out in the following list, and that they be sold **subject to the analysis and report of the Consulting Chemist of the Bath and West and Southern Counties Society.**

FERTILISERS.

Raw Bones, Bone-meal, or **Bone-dust** to be guaranteed "PURE," and to contain not less than 45 per cent. of Phosphate of Lime, and not less than 4 per cent. of Ammonia.

Steamed or "**Degelatinised**" **Bones** to be guaranteed "PURE," and to contain not less than 55 per cent. of Phosphate of Lime, and not less than 1 per cent. of Ammonia.

Mineral Superphosphate of Lime to be guaranteed to contain a certain percentage of "Soluble Phosphate." [From 25 to 28 per cent. of Soluble Phosphate is an ordinarily good quality.]

Dissolved Bones to be guaranteed to be "made from raw bone and acid only," and to be sold as containing stated percentages of Soluble Phosphate, Insoluble Phosphates, and Ammonia.

Compound Artificial Manures, Bone Manures, Bone Compounds, &c., to be sold by analysis stating the percentages of Soluble Phosphate, Insoluble Phosphates, and Ammonia contained.

Basic Slag to be guaranteed to contain a certain percentage of Phosphoric Acid, and to be sufficiently finely ground that 80 to 90 per cent. passes through a sieve having 10,000 meshes to the square inch.

Peruvian Guano to be described by that name, and to be sold by analysis stating the percentages of Phosphates and Ammonia.

Sulphate of Ammonia to be guaranteed to be "PURE," and to contain not less than 24 per cent. of Ammonia.

Nitrate of Soda to be guaranteed to be "PURE," and to contain 95 per cent. of Nitrate of Soda.

Kainit to be guaranteed to contain 23 per cent of Sulphate of Potash.

All fertilisers to be delivered in good and suitable condition for sowing.

FEEDING-STUFFS.

Linseed Cake, Cotton Cake (Decorticated and Undecorticated), and **Rape Cake** (for feeding purposes) to be pure, i.e., prepared *only* from one kind of seed from which their name is derived, and to be in sound condition. The report of the Consulting Chemist of the Bath and West and Southern Counties Society to be conclusive as to the " purity " or otherwise of any feeding-stuffs. The percentages of Oil and Albuminoids must also be guaranteed.

Mixed Feeding Cakes, Meals, &c., to be sold on a guaranteed analysis.

All Feeding-Stuffs to be sold in sound condition, and to contain nothing of an injurious nature or worthless for feeding purposes.

INSTRUCTIONS FOR SELECTING AND SENDING SAMPLES FOR ANALYSIS.

GENERAL RULES.

1.—A sample taken for analysis should be fairly *representative of the bulk* from which it has been drawn.

2.—The sample should reach the Analyst *in the same condition* as it was at the time when drawn.

FERTILISERS.

When **Fertilisers** are delivered in bags, select four or five of these from the bulk, and either turn them out on a floor and rapidly mix their contents, or else drive a shovel into each bag and draw out from as near the centre as possible a couple of shovelfuls of the manure, and mix these quickly on a floor.

Halve the heap obtained in either of these ways, take one-half (rejecting the other) and mix again rapidly, flattening down with the shovel any lumps that appear. Repeat this operation until at last only some three or four pounds are left.

From this fill three tins, holding from ½ lb. to 1 lb. each, mark, fasten up and seal each of these. Send one for analysis, and retain the others for reference.

Or,—the manure may be put into glass bottles provided with well-fitting corks; the bottles should be labelled and the corks sealed down. The sample sent for analysis can be packed in a wooden box and sent by post or rail.

When manures are delivered in bulk, portions should be successively drawn from *different parts* of the bulk, the heap being turned over now and again. The portions drawn should be thoroughly mixed, sub-divided, and, finally, samples should be taken as before, except that when the manure is coarse and bulky it is advisable to send larger samples than when it is in a finely-divided condition.

FEEDING-STUFFS.

Linseed, Cotton, and other Feeding Cakes.—If a single cake be taken three strips should be broken off right across the cake and from the middle portion of it, one piece to be sent for analysis, and the other two retained for reference. Each of the three pieces should be marked, wrapped in paper, fastened up and sealed. The piece forwarded for analysis can be sent by post or rail.

A more satisfactory plan is to select four to six cakes from different parts of the delivery, then break off a piece about four inches wide from the middle of each cake, and pass these pieces through a cake-breaker. The broken cake should then be well mixed, and three samples of about 1 lb. each should be taken and put in tins or bags duly marked, fastened, and sealed as before. One of these lots

should be sent for analysis, the remaining two being kept for reference. It is advisable, also, with the broken pieces, to send a small strip from an unbroken cake.

Feeding Meals, Grain, &c.—Handfuls should be drawn from the centre of half-a-dozen different bags of the delivery; these lots should then be well mixed. and three ½ lb. tins or bags filled from the heap, each being marked, fastened up, and sealed. One sample is to be forwarded for analysis and the others retained for reference.

SOILS, WATERS, &c.

Soils.—Have a wooden box made, 6 inches in length and width, and from 9 to 12 inches deep, according to the depth of soil and subsoil of the field. Mark out in the field a space of about 12 inches square; dig round in a slanting direction a trench, so as to leave undisturbed a block of soil and its subsoil 9 to 12 inches deep; trim this block to make it fit into the wooden box, invert the open box over it, press down firmly, then pass a spade under the box and lift it up gently, turn over the box, nail on the lid, and send by rail. The soil will then be received in the position in which it is found in the field.

In the case of very light, sandy, and porous soils, the wooden box may be at once inverted over the soil and forced down by pressure, and then dug out.

Waters.—Samples of water are best sent in glass-stoppered Winchester bottles holding half a gallon. One such bottle is sufficient for a single sample. Care should be taken to have these scrupulously clean. In taking a sample of water for analysis it is advisable to reject the first portion drawn or pumped, so as to obtain a sample of the water when in ordinary flow. The bottle should be rinsed out with the water that is to be analysed, and it should be filled nearly to the top. The stopper should be secured with string, or be tied over with linen or soft leather. The sample can then be sent carefully packed either in a wooden box with sawdust, &c., or in a hamper with straw.

Milk.—A pint bottle should be sent in a wooden box.

GENERAL INSTRUCTIONS.

Time for Taking Samples.—All samples, both of fertilisers and feeding-stuffs, should be taken as soon after their delivery as possible, and should reach the Analyst within *ten days* after delivery of the article. In every case it is advisable that the Analyst's certificate be received before a fertiliser is sown or a feeding-stuff is given to stock.

Procedure in the event of the Vendor wishing Fresh Samples to be Drawn.—Should a purchaser find that the Analyst's certificate shows a fertiliser or feeding-stuff not to come up to the guarantee given him, he may inform the vendor of the result and complain accordingly. He should then send to the vendor *one* of the two samples which he has kept for reference. If, however, the vendor should demand that a fresh sample be drawn, the purchaser must allow this, and also give the vendor an opportunity of being present, either in person or through a representative whom he may appoint. In that case, three samples should be taken in the presence of both parties with the same precautions as before described, *each* of which should be duly packed up, labelled and *sealed* by both parties. One of these is to be given to the vendor, one is to be sent to the Analyst, and the third is to be kept by the purchaser for reference or future analysis if necessary.

All samples intended for the Consulting Chemist of the Society should be addressed (postage or carriage prepaid) to Dr. J. AUGUSTUS VOELCKER, M.A., F.I.C., Stuart House, 1, Tudor Street, New Bridge Street, London, E.C. Separate letters of instruction should be sent at the same time.

FINANCIAL STATEMENTS

FOR

1916

WITH ITEMS OF* 1915 *FOR COMPARISON.

The Bath and West and

Dr. CASH ACCOUNT FOR THE YEAR ENDING DEC. 31st,

RECEIPTS.	1916.						1915.		
	£	s.	d.	£	s.	d.	£	s.	d.
DIVIDENDS AND INTEREST :—									
War Loan Stock	131	17	6				74	9	8
South Australian Stock	32	12	10				36	14	0
New Zealand Stock	43	4	4				48	11	10
India Stock	178	2	0				200	4	10
Queensland Stock	86	13	4				97	8	11
New South Wales Stock	55	4	1				62	1	3
Canadian Pacific Stock	47	5	0				53	5	0
Consols (now converted into War Loan)							129	6	2
Interest on Deposit							19	8	11
	574	19	1				721	10	7
Income Tax deducted from 3 years' Dividends and since returned.	204	3	3	779	2	4			
GENERAL RECEIPTS :—									
Sale of Waste Paper, &c.				0	13	6	0	10	9
SUBSCRIPTIONS FROM MEMBERS :—									
Arrears	15	6	0				30	18	0
Governors	148	3	0				160	11	0
Subscribers of £1 and upwards	655	5	0				748	9	0
Ditto of 10s.	6	10	0				7	0	0
				825	4	0	946	18	0
LIFE COMPOSITIONS							20	0	0
JOURNAL :—									
Sales	15	4	6				3	14	7
Advertisements	30	6	4				29	13	8
				45	10	10	33	8	3
Carried forward			£	1,650	10	8			

Southern Counties Society.

1916, WITH COMPARATIVE STATEMENT FOR 1915. Cr.

PAYMENTS.	1916. £ s. d.	1916. £ s. d.	1915. £ s. d.
SALARIES.—			
Secretary (including Clerks, &c.)	1,050 0 0		1,050 0 0
Auditor	20 0 0		20 0 0
Consulting Chemist	30 0 0		30 0 0
		1,100 0 0	1,100 0 0
MISCELLANEOUS:—			
Printing	6 4 6		15 9 5
Stationery and Finance Books	21 5 1		28 19 4
Postages, Telegrams, Cheque and Receipt Stamps	16 0 11		56 15 6
Ground Rent and Rates	20 19 0		22 14 2
Property Tax	3 12 6		3 2 5
Travelling Expenses	12 16 2		24 0 2
Carriage of Goods	1 9 7		11 13 4
Directories and Reference Books	0 13 5		2 2 7
Subscriptions and Grant	6 11 0		7 12 0
Repairs and Fittings	5 12 10		5 17 6
Hire of London Rooms for Meetings	1 1 0		3 3 0
Fuel and Light	4 13 0		6 16 1
Finance Committee's Expenses	4 14 6		11 1 10
Telephone	7 16 4		7 16 0
Bank Charges	3 3 5		39 0 0
Typewriter	4 0 0		
Miscellaneous	0 12 6		1 6 7
Relief to Allies Fund			100 0 0
		123 11 6	347 9 11
JOURNAL:—			
Editor	100 0 0		100 0 0
Associate Editor	100 0 0		100 0 0
Printing and Binding	136 18 9		140 8 10
Plans and Blocks	9 13 0		14 3 10
Journal Distribution	20 15 2		17 12 8
Postages, Stationery, Reference Books, &c.	3 14 10		4 10 8
Payments to Authors	37 11 0		36 14 0
		408 12 9	418 10 0
Carried forward	£	1,632 4 3	

Dr. CASH ACCOUNT—*continued.*

RECEIPTS.	1916. £ s. d.	1916. £ s. d.	1915. £ s. d.
Brought forward .		1,650 10 8	
SHOW :—			
Implements			1,400 4 6
Horses, Cattle, Sheep and Pigs . . .			1,613 8 7
Cheese and Butter			52 18 11
Working Dairy			145 4 3
Cider			8 10 0
Admissions			2,290 13 3
Unapportionable			598 4 10
Subscriptions from Towns			400 0 0
			6,504 4 4
		1,650 10 8	8,226 11 11
DEPOSIT RETURNED			1,500 0 0
Balance due to Bank, Dec. 31st . .		269 13 2	16 16 4
	£	1,920 3 10	9,743 8 3

CASH ACCOUNT—*continued.* Cr.

PAYMENTS.		1916.		1915.
		£ s. d.	£ s. d.	£ s. d.
Brought forward .			1,632 4 3	
SHOW:—				
Implements				559 7 11
Horses, Cattle, Sheep and Pigs . . .				4,023 10 6
Deferred Prizes		7 0 0		
Forestry				5 10 0
Music				149 12 5
Horticulture				159 5 11
Bees				2 12 6
Cheese and Butter				184 7 5
Working Dairy				446 6 6
Cider				88 8 6
Public Announcements				427 17 8
Unapportionable:—				1,676 9 7
Superintendent of Works .	150 0 0			
Insurance of Plant . .	1 15 0			
		151 15 0		
			158 15 0	7,723 12 11
EXPERIMENTS:—				
Cider Institute			100 0 0	100 0 0
			1,890 19 3	9,684 12 10
INVESTMENTS			12 8 3	
Balance due to Bank, Jan. 1st . .			16 16 4	58 15 5
		£	1,920 3 10	9,743 8 3

Jan. 20th, 1917.

I hereby certify that I have examined the foregoing accounts for the year ending December 31st, 1916, compared the payments entered with the vouchers, and found them all in order and correct.

F. CLIFFORD GOODMAN, F.C.A.,
Auditor.

Passed by Council,
Jan. 30*th*, 1917,

THOS. F. PLOWMAN,
Secretary.

ASSETS AND LIABILITIES ACCOUNT TO DECEMBER 31st, 1916, WITH COMPARISON FOR 1915.

ASSETS.

	Par. Value. £ s. d.	Actual Cost £ s. d.	Market Value on Dec. 31. £ s. d.	1916. £ s. d.	1915. £ s. d.
INVESTMENTS				15,069 15 10	16,804 6 11
New Zealand Stock	1,568 1 6	1,500 0 0	1,129 0 3		
War Loan Stock	3,894 11 11	5,809 19 6	3,750 18 10		
Ditto to replace capital lost on conversion	12 12 10	12 8 3			
India Stock	7,538 15 1	7,277 5 1	4,334 15 8		
Queensland "	2,751 9 0	3,000 0 0	2,393 15 3		
N. S. Wales "	1,752 8 10	2,000 0 0	1,437 0 0		
Canadian Pacific Rly. "	1,500 0 0	1,576 2 6	1,185 0 0		
South Australian "	1,036 3 3	1,000 0 0	839 5 10		
	20,054 2 5	22,175 15 4	15,069 15 10		
DUE FOR REPLACEMENT OF CAPITAL				30 0 0	12 8 3
INCOME TAX RECOVERABLE				114 5 6	
PLANT:— Works			185 12 10		206 5 4
Dairy			15 5 7		16 19 7
				200 18 5	223 4 11
HOUSE PROPERTY			633 10 7		633 10 7
FURNITURE AND FITTINGS			162 0 5		162 3 6
				795 11 0	795 14 1
SUBSCRIPTION ARREARS				94 18 0	66 7 0
			£	16,305 8 9	17,902 1 2

LIABILITIES.

	1916. £ s. d.	1915. £ s. d.
DEFERRED PRIZES		7 0 0
JOURNAL, cost of, estimated at	450 0 0	450 0 0
DUE TO BANK	269 13 2	16 16 4
DUE TO FUND FOR REPLACEMENT OF CAPITAL	30 0 0	12 8 3
	749 13 2	486 4 7
BALANCE	15,555 15 7	17,415 16 7
£	16,305 8 9	17,902 1 2

January 20th, 1917.

I hereby certify that I have audited the above Balance Sheet, and that, in my opinion, it is correct, and shows the true position of the Society's affairs according to the Books. The securities for the Society's Investments have been produced to me, and I have found them in order. The various Stocks have been valued by the Society's Bankers.

F. CLIFFORD GOODMAN, F.C.A., Auditor.

Passed by Council

January 30th, 1917.

THOS. F. PLOWMAN, Secretary.

Bath and West and Southern Counties Society,

FOR THE

Encouragement of Agriculture, Arts, Manufactures and Commerce.

List of Members, 1917.

PATRON.

HIS MOST GRACIOUS MAJESTY THE KING.

PRESIDENT

THE RIGHT HON. THE EARL OF COVENTRY.

TRUSTEES.

THE MOST HON. THE MARQUIS OF BATH.
SIR C. T. D. ACLAND, BART.
C. L. F. EDWARDS, ESQ.

Names thus (*) distinguished are Governors.
Names thus (†) distinguished are Life Members.
*** *Members are particularly requested to make the Secretary acquainted with any errors in the names of residences.*

Name.	Residence.	Subscriptions. £	s.	d.
*†His Most Gracious Majesty the King	Windsor Castle	..		
Ackers, Chas. P.	Huntley Manor, Gloucester	1	0	0
Ackland, J.	Cutton Farm, Poltimore, Exeter	1	0	0
Acland, Alfred Dyke	. . . .	1	0	0
†Acland, Rt. Hon. A. H. Dyke	29, St. James' Court, Buckingham Gate, London, S.W.	..		
*Acland, Sir C. T. D., Bart.	Killerton, Exeter	5	0	0
Acland, Right Hon. F. Dyke, M.P.	93, Bedford Gardens, Campden hill, London, W.	1	0	0
Adams, E. C.	Brentwood, Combe Down, Bath	1	0	0
Adams, G. & Son	Wadley House, Faringdon, Berks	1	0	0
Adams, R. and H. (Ltd.)	10, Queen Square, Bristol	1	0	0
Adeane, C. R. W.	Babraham, Cambridge	1	0	0
†Aitken, G. H.	Longleat Estate Office, Warminster	..		
Akers, E.	St. Fagans, Cardiff	1	0	0
Alexander, D.	Cardiff	1	1	0

Name.	Residence.	Subscriptions. £	s.	d.
Alexander, H. G.	Dinas Powis, Cardiff	1	1	0
Allen & Sons	Cheese Merchants, Shepton Mallet.	1	1	0
†Allen, James D.	Springfield House, Shepton Mallet		..	
Allen, W. T.	West Bradley, Glastonbury	1	0	0
Allin, Mrs. N.	Townsend Manor Farm, Over Wallop, Stockbridge	1	0	0
Allix, C. I. L.	St. Germans, Cornwall	1	0	0
Allsebrook, A.	Link Elm, Malvern Link	1	1	0
Ames, F.	Hawford Lodge, Worcester	1	0	0
Andrews, S. Fox-	Union Street, Bath	1	0	0
Anglo-Continental Guano Works	Dock House, Billiter Street, E.C.	1	0	0
Anglo-Swiss Condensed Milk Company	Chippenham	1	0	0
Arnott, G. C.	69, Fenchurch Street, London, E.C.	1	0	0
†Ashcomb, Lord	Denbies, Dorking		..	
†Ashcroft, W.	13, The Waldrons, Croydon		..	
Ashford, E. C., M.D.	The Moorlands, Bath	1	0	0
*Astor, Hon. Waldorf	Cliveden, Taplow, Bucks	2	0	0
Augustein, J. R.	Holbrook House, Wincanton	1	0	0
Aungier, J.	Lynwick, Rudgwick	1	0	0
†Avebury, Lord	High Elms, Hayes, Kent		..	
†Aveling, Thomas L.	Rochester		..	
Avon Manure Company (Ld.)	St. Philip's Marsh, Bristol	1	0	0
Badcock, H. Jefferies	Broadlands, Taunton	1	0	0
Bainbridge, Mrs. R. C.	Elfordleigh, Plympton, South Devon	1	0	0
Baker, G. E. Lloyd	Hardwicke Court, Gloucester	1	0	0
†Baker, M. G. Lloyd	The Cottage, Hardwicke, Glos.		..	
†Baker, L. J.	10, Ennismore Gardens, London, S.W.		..	
Balston, R. J.	Bilsington Priory, Ashford, Kent	1	0	0
*Balston, W. E.	Barvin, Potters Bar, Herts	2	0	0
Bamfords (Ltd.)	Uttoxeter	1	0	0
Barford and Perkins (Ltd.)	Peterborough	1	0	0
Barham, G. T.	Sudbury Park, Wembley, Middlesex	1	0	0
Baring, Hon. A. H.	The Grange, Alresford, Hants	1	0	0
*Barker-Hahlo, H.	Camerton Court, Bath	2	0	0
Barlow, Sir J. Emmott, Bart., M.P.	Torkington Lodge, Hazel Grove, near Stockport	1	0	0
Barrett, Col. W.	Hill House, Minehead	1	0	0
Barstow, J. J. J.	The Lodge, Weston-super-Mare	1	1	0
Barton, D. J.	. . . .	0	10	0
Bassett, A. F.	Tehidy, Camborne, Cornwall	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Bates, W. J. & Co.	Victoria Iron Works, Denton, Manchester	1	0	0
*†Bath, Marquis of	Longleat, Warminster		..	
Bath and Somersetshire Dairy Co. (Ltd.)	Bath	1	0	0
Bath and Wells, The Bishop of	The Palace, Wells	1	1	0
Bath Gas Company	Bath	1	0	0
†Bathurst, Capt. C., M.P.	Lydney Park, Glos.		..	
Batten, Col. Cary	Abbotsleigh, Bristol	1	0	0
Batten-Pooll, R. H.	Road Manor, Bath	1	0	0
†Baxendale, J. Noel	Froxfield Green, Petersfield		..	
Bayly, J.	Highlands, Ivybridge, S. Devon	1	0	0
Beauchamp, E. B.	Trevince, Redruth	1	0	0
Beauchamp, F. B.	Woodborough House, Peasedown St. John, Bath	1	1	0
*Beaufort, Duke of	Badminton, Chippenham	2	2	0
Beaufoy, M. H.	Coombe Priory, Shaftesbury	1	0	0
Bennett, Brothers	*Journal* Office, Salisbury	1	1	0
Bennett, R. A.	Thornbury, Glos.	1	0	0
Bennetts, J. M.	Killaganoon, St. Feock, Cornwall	1	1	0
Bentall, Edward H. & Co.	Heybridge, Maldon, Essex	1	0	0
Benyon, H. A.	Englefield House, Reading	1	1	0
*Benyon, J. Herbert	Englefield House, Reading	5	0	0
Berryman, F. H.	Field House, Shepton Mallet	1	1	0
Best, Major T. G.	East Carleton Manor, Norwich	1	0	0
†Best, Capt. W.	Vivod, Llangollen, North Wales		..	
Best, Hon. Bertha	Charlton House, Ludwell, Salisbury	1	0	0
Best, Hon. J. W.	Charlton House, Ludwell, Salisbury	1	0	0
Beynon, J. W.	16, Mount Stuart Square, Cardiff	1	1	0
Birmingham, C.	Nutscale, The Parks, Minehead	0	10	0
†Blackburn, H. P.	Donhead Hall, Salisbury		..	
Blackstone & Co. (Ltd.)	Rutland Iron Works, Stamford	1	1	0
Blake, Col. M. Lock	Bridge, S. Petherton	1	0	0
Blathwayt, R. W.	Dyrham Park, Chippenham	1	1	0
Board, R. J.	Skinner, Board & Co., Rupert St., Bristol	1	0	0
Bolden, Rev. C.	Preston Bissett, Buckingham	1	0	0
Bolitho, R. F.	Ponsandane, Penzance	1	1	0
Bolitho, T. R.	Trengwainton, Hea Moor, Cornwall	1	1	0
Bond E. (W. Evans & Co.)	Hele, Cullompton	1	0	0
Boscawen, Rev. A. T.	Ludgvan Rectory, Long Rock, R.S.O., Cornwall	1	0	0
Boscawen, Townshend E.	2, Old Burlington St., London, W.	1	0	0
Bourne, W. W.	Garston Manor, Watford, Herts	1	0	0
Bouverie, H. P.	Brymore, Bridgwater	1	0	0
†Bowen-Jones, Sir J., Bart.	The Woodlands, Bicton, near Shrewsbury		..	

Name.	Residence.	Sub-scriptions. £	s.	d.
†Bowerman, Alfred	Hewelsfield Court, St. Briavels, Glos.	..		
Boyle, Capt. M.	The Manor, Staple Fitzpaine, Taunton	1	0	0
Braby, F. & Co.	Ashton Gate Works, Bristol	1	0	0
Bradford, Thomas & Co.	Salford, Manchester	1	0	0
Brand, Admiral Hon. T. S.	Glynde, Lewes, Sussex	1	0	0
†Brassey, A.	Heythrop, Chipping Norton	..		
*†Brassey, H. L. C.	Apethorpe Hall, Wansford, Northants	..		
Bridges, J. H.	Ewell Court, near Epsom	1	1	0
†Brinkley, Rev. W. F. B.	The Vicarage, Abbots Leigh, Bristol	..		
Bristol Times and Mirror, Proprietors of	Bristol	1	0	0
Bristol Wagon and Carriage Works Co. (Ltd.)	Lawrence Hill, Bristol	1	1	0
Britten, Forester	Kenswick Manor, Worcester	1	0	0
†Broadmead, W. B.	Enmore Park, Bridgwater	..		
†Brocklehurst, H. D..	Sudeley Castle, Winchcombe	..		
Brockman, F. D.		1	0	0
Broderip, E.	Cossington, Somerset	1	0	0
Brown, F. E.	1,403 Neath Road, Swansea	1	0	0
Browning, Albert, M.A.	The Homestead, Combe Park, Bath	1	1	0
†Buckingham, Rev. Preb.	The Rectory, Doddiscombsleigh, Exeter, Devon	..		
Buck, D.	White House, Little Mill, Pontypool	1	0	0
Buckley, W.	Moundsmere Manor, Basingstoke	1	0	0
Budd, Felix S.	Clarendon House, Stow Park, Newport, Mon.	1	0	0
Budd, J. E.	Tidebrook Manor, Wadhurst, Sussex	1	0	0
Burghclere, Lord	48, Charles Street, London, W.	1	0	0
Burnard, R.	Cattedown, Plymouth	1	0	0
Burrell, C. and Sons	St. Nicholas Works, Thetford	1	0	0
Burrell, Sir M. R., Bart.	Knepp Castle, Horsham, Sussex	1	0	0
†Bush, H. G.	The Grove, Alveston, Glos.	..		
Bush, Mrs. L. E.	St. Mary's, Atlantic Road South, Weston-s-Mare	1	1	0
Busk, H. G.	Bransford, Worcester	1	1	0
Buswell, C. and W.	Torquay	1	0	0
*Bute, The Marquis of	The Castle, Cardiff	2	0	0
Butland, B.	Leigham, Plympton	1	0	0
Butler, I.	Bryn Corner, Pontrhyclyrun, near Newport, Mon.	1	0	0
Byng, Col. Hon. C.	70, Ashley Gardens, London, S.W.	1	1	0

Name.	Residence.	Subscriptions. £	s.	d.
Cæsar, H. and J.	Knutsford, Cheshire	1	0	0
Calthrop, F. C.	56, Naylor Street, Liverpool	1	0	0
Campbell, J.	93, Mansel Street, Swansea	1	0	0
Candy, T. C.	Woolcombe, Cattistock, Dorset	1	0	0
Carew, C.	Collipriest, Tiverton	1	0	0
Carnarvon, Earl of	Highclere Castle, Newbury	1	1	0
*Carr, Jonathan	Wood House, Twerton-on-Avon, Bath	2	2	0
†Carruthers W., F.R.S.	14, Vermont Road, Norwood, London, S.E.	..		
Carson, J.	Crystalbrook, Theydon Bois, Essex	1	0	0
†Carter, E.	East Upton, Ryde, Isle of Wight	..		
Carter, G. V.	Waterston Manor, Dorchester	1	1	0
Carter, Dunnett & Beale	Raynes Park, London, S.W.	1	0	0
Cartwright, T. G.	30, Beaufort Gardens, London, S.W.	1	0	0
Carver, H. R.	West House, Chilton Polden, Bridgwater	1	0	0
Cary, Edmund	Pylle, Shepton Mallet	0	10	0
†Cary, John	The Priory, Shepton Mallet	..		
†Cary, W. H.	Mantua, Steeple Ashton, Trowbridge	..		
Cattybrook Brick Co. (Ltd.)	Baldwin Street, Bristol	1	0	0
Cave, Sir C., Bart.	Lidbury Manor, Sidmouth	1	0	0
Cave, C. H.	Rodway Hill House, Mangotsfield, Bristol	1	0	0
Cazalet, W. M.	Fairlawne, Tonbridge	1	0	0
Chapman, W. W.	Mowbray House, Norfolk Street, Strand, London, W.C.	1	1	0
Chester-Master, Lt.-Col. R.	St. Clair, The Park, Cheltenham	1	0	0
Chichester, Major C. H.	Hall, Bishops Tawton, Barnstaple	1	0	0
†Chick, J. H.	Wynford Eagle, Maiden Newton, Dorset	..		
†Chick, W. D.	Compton Valence, Dorchester	..		
Childs, C., M.D.	Boscarn, Looe, R.S.O., Cornwall	1	0	0
Christie, A. L.	Tapeley Park, Instow, N. Devon	1	1	0
Churchill, The Viscount, G.C.V.O.	Carlton Club, Pall Mall, London	1	0	0
†Churchward, F.	Hill House, Stoke Gabriel, near Totnes	..		
*Clarendon, Earl of	The Grove, Watford	2	2	0
Clark, H. A.	Hinton Field, Hinton Charterhouse, Bath	1	0	0
†Clark, J. J.	Goldstone Farm, Hove, Sussex (Hon. Local Sec., 1885)	..		
Clark, W. S.	Street, Glastonbury	1	0	0
Clark, W. H.	Rutland Cottage, Combe Down, Bath	1	1	0
Clarke, J. B.	Overleigh House, Street, Somerset	1	0	0
Clerk, Lieut.-Col. R. M.	Charlton House, Shepton Mallet	1	0	0

Name.	Residence.	£	s.	d.
*Clifden, Viscount	Lanhydroc, Bodmin	2	0	0
Clinton, Lord	Heanton Satchville, Dolton, N. Devon	1	0	0
Clutton, R. W.	Hartswood, Reigate	1	0	0
Coaker, J.	Blagdon Barton, Paignton, Devon	1	0	0
Cobb, H. M.	Higham, Rochester	1	0	0
Cobb, R.	Larkin Hall, near Rochester	1	0	0
Coleridge, Hon. G.	Toddington, Winchcombe	1	0	0
Collins, J. J. S.	St. George's Lodge, Oldfield Park, Bath	1	1	0
Colman, Sir J., Bart.	Gatton Park, Surrey	1	0	0
Colmer, Jas. (Ltd.)	Union Street, Bath	1	0	0
Colthurst, Symons & Co. (Ltd.)	Bridgwater	1	0	0
Colville, H. K.	North Cerney House, Cirencester	1	0	0
Cook, R.	Widhayes, Tiverton	1	0	0
†Cookson, H. T.	Sturford Mead, Warminster		..	
Cooling, G. and Sons	Northgate Street, Bath	1	1	0
Cooper, Sir G., Bart.	Hursley Park, Winchester	1	0	0
Cope, W.	Southerndown, Glam.	1	1	0
Corbet, E. W. M.	Bute Estate Office, Cardiff	1	1	0
Corbett, Thomas	Perseverance Iron Works, Shrewsbury	1	0	0
Corker & Bevan	Swansea	1	1	0
†Cork and Orrery, The Earl of	22, Ryder Street, London, S.W.		..	
†Corner, H. W.	Manor House, Inglescombe, Bath		..	
†Cornwallis, F. S. W.	Linton Park, Maidstone		..	
Cory, Sir Clifford	Llantarnam Abbey, Mon.	1	0	0
Cory, E., London, Gloucester and N. Hants Dairy Co. (Ltd.)	Whatley Road, Clifton, Bristol	1	0	0
Cottam, H. C. D.	The Old Rectory, Wilton, near Salisbury	1	0	0
†Cotterell, Sir J. R. G., Bart.	Garnons, Hereford		..	
Coultas, J. R.	Allington, near Grantham	1	0	0
Coultrip, A. W.	Norwood Manor, East Church, Kent	1	0	0
†Courage, Raymond	Shenfield Place, Brentwood, Essex		..	
†Coussmaker, Lt.-Col. G.	Westwood, Normandy, Guildford, Surrey		..	
*Coventry, The Earl of	Croome Court, Worcester	2	0	0
Cox, B.	Pwlpen Farm, Christchurch, Newport, Mon.	0	10	0
Cox & Sons	47, City Road, Cardiff	1	0	0
Crewdson, J. D.	Syde, near Cheltenham	1	0	0
Crick, Thomas	Great Ash, Winsford, Dulverton	0	10	0
Cridlan, J. J.	Maisemore Park, Gloucester	1	0	0
Crutchley, P. E.	Limminghill Lodge, Ascot	1	0	0
Cuming, A. P.	Moreton Hampstead, Devon	1	0	0

Name.	Residence.	£	s.	d.
Cundall, H. M., I.S.O., F.S.A.	Richmond Hill, Surrey . .	1	0	0
†Curre, E.	Itton Court, Chepstow . .	..		
Currie, L.	Minley Manor, Farnborough, Hants	1	0	0
Dairy Supply Company (Ltd.)	Museum St., Bloomsbury, London	1	0	0
†Daniel, H. T. . . .	The Red House, Cannington, Bridgwater	..		
Daniel, Thos. C. . .	Stuckeridge, Bampton, North Devon	1	1	0
Darby, A. E. W. . .	Little Ness, Shrewsbury . .	1	0	0
Darby, E.	Liscombe, Dulverton . . .	1	0	0
†Darell, D. . . .	Hillfield House, Stoke Fleming, near Dartmouth . . .	..		
†Davenport, Rev. Geo. H. .	Foxley, Hereford	..		
†Davey, J. Sydney . .	Brockym, Cury - Cross - Lanes, Cornwall	..		
Davey, Sleep, & Co. (Ltd.) .	Excelsior Plough Works, Plymouth	1	0	0
David & David . . .	Old Bank Chambers, 27, High Street, Cardiff	1	0	0
Davies, D. . . .	The Borough Stores, College Street, Swansea	1	1	0
Davis, F. L. . . .	7, Bute Crescent, Cardiff . .	1	1	0
†Davis, H. J. . . .	Sutton Montis, Sparkford, S.O., Somerset	..		
Davis & Co. . . .	75, George Street, Oxford . .	1	0	0
Daw, J. E. . . .	Exeter	1	1	0
Day and Sons (Ltd.) . .	Crewe	1	0	0
†Deacon, W. S. . . .	Poynters, Cobham, Surrey . .	..		
De Bertodano, B. . .	Cowbridge House, Malmesbury .	1	0	0
De Blaquiere, Lord . .	3, The Circus, Bath . . .	1	0	0
De Hamel, E. . . .	Middleton Hall, Tamworth . .	1	0	0
Demuth, R. H. . . .	. . . .	1	0	0
Dening, C. & Co. . .	Chard, Somerset	1	0	0
Dennis, S. . . .	Latton, Cricklade, Wilts . .	1	0	0
Denny, G. A. . . .	. . . .	1	0	0
†Devas, H. G. . . .	Hartfield, Hayes, Kent . .	..		
*Devon, The Earl of . .	Powderham Castle, Devon . .	2	0	0
*Devonshire, Duke of .	Chatsworth, Derbyshire . .	5	0	0
Dew, W. S. . . .	Newton St. Loe, Bristol . .	1	0	0
Dickson and Robinson .	Cathedral Street, Manchester .	1	1	0
Dickson's (Ltd.) . .	Chester	1	1	0

Name.	Residence.	Subscriptions. £	s.	d.
†Digby, Lord	Minterne, Cerne Abbas	..		
Digby, F. J. B. Wingfield	Sherborne	1	0	0
†Dobson, H. V.	Perridge House, Shepton Mallet	..		
Dodington, R. M.	Horsington Park, Templecombe	1	1	0
Donati, A. W.	Estate Office, Holnicote, Taunton	1	0	0
Dormer, Capt. C. W. C.	Rousham, Oxford	1	0	0
Drummond, Col. F. D. W.	Cawdor Estate Office, Carmarthen	1	0	0
Drummond, H. W.	Broad Room, L. & S.W.R., Waterloo Station, London	1	0	0
Duchesne M. C.	Farnham Common, Slough, Bucks.	1	0	0
*Ducie, Earl of	Tortworth Court, Falfield, R.S.O., Glos.	2	0	0
Dugdale, J. M.	Llwyn, Llanfyllin, near Oswestry	1	0	0
†Dunboyne, Lord	Greendale, Clyst St. Mary, Exeter	..		
Duncan, R.	Rhoose, near Barry	1	0	0
Dunlop, I. M.	Avonhurst, Sneyd Park, Bristol	1	0	0
*Dyke, Rt. Hon. Sir W. Hart, Bart.	Lullingston Castle, Eynsford	2	2	0
Eagle Range and Gas Stove Company (Ltd.)	Catherine Street, Aston, Birmingham	1	0	0
Eastwood, A. C.	Leigh Court, Taunton	1	0	0
*†Eastwood, J. E.	Gosden House, Bramley, Guildford	..		
Economic Fencing Company (Ltd.)	Billiter House, Billiter Street, London, E.C.	1	0	0
Eden, R. H. H.	Sherborne, Dorset	1	0	0
†Edgcumbe, Sir Robert Pearce	. . . .	..		
†Edmondson, A.	Woodclose, Silverdale, Lancashire	..		
Edwards, A. P.	Gogs House, Wedmore, Somerset	1	1	0
Edwards, C. L. Fry	The Court, Axbridge, Somerset	1	0	0
Edwards, W. H. G.	Butcombe Court, Wrington	1	0	0
Eldridge, Pope & Co.	Dorchester	1	0	0
Elliott, Sir Thomas H., Bart.	4, Whitehall Place, London, S. W.	1	1	0
Elliott, T. M.	Biddestone, Chippenham	1	0	0
Elton, B. A.	Clevedon Court, Somerset	1	0	0
*Elton, Sir E., Bart.	Clevedon Court, Clevedon	2	2	0
Enderby, Miss E. M.	Beckington, Bath	1	1	0
Enfield, Viscount	Dancer's Hill, Barnet	1	0	0
Ensor, T. & Sons	Auctioneers, Dorchester	1	0	0
Errington, R.	Victoria Mills, Sunderland	1	0	0

Name.	Residence.	Subscriptions. £ s. d.
Esdaile, C. E. T.	Cothelstone House, Taunton	1 0 0
Evans, H. M. Glynn	Plasissa, Llangennech, Carmarthenshire	1 0 0
Evans, H. R.	Court of Noke, Pembridge, Herefordshire	1 0 0
†Evan-Thomas, Commander A.	Caerwnon, Builth Wells, R.S.O.	..
†Eve, Mr. Justice	Pullabrook, Bovey Tracy, South Devon	..
Evelyn, Mrs.	Wotton House, nr. Dorking	1 0 0
*Falmouth, Viscount	Tregothnan, Truro	2 0 0
Faringdon, Lord	Buscot Park, Faringdon	1 1 0
†Farmer, S. W.	Little Bedwyn, Wilts	..
†Farwell, Capt. E. W.	Queen's Parade, Bath	..
Fastnut (Ltd.)	115, Newgate Street, London	1 1 0
Faudel-Phillips, H.	Mapleton Stud, Edenbridge, Kent	1 0 0
Fenton, A. D.	Maristow, Roborough, S. Devon	0 10 0
Ferrand, G. F.	Morland Hall, Alton, Hants	1 0 0
Finlay, Col. Alexander	Little Brickhill, Bletchley, Bucks	1 0 0
Finn, L. & G.	Westwood Court, Faversham	1 0 0
Fleming, J. Willis	Stoneham Park, Eastleigh, Hants	1 0 0
†Fletcher, Lionel J. W.	West Farleigh, Maidstone	..
Flower, James	Chilmark, Salisbury	1 0 0
*†Forester, Capt. F. W.	Saxilbye Park, Melton Mowbray	..
Forrest, Col. W.	St. Fagan's, Cardiff	1 0 0
Forster, J. C.	Clatford Mills, Andover	1 0 0
†Fortescue, J. B.	Boconnoc, Lostwithiel, Cornwall	..
Foster-Harter, G. L.	Salperton Park, Compton Abdale, R.S.O., Glos.	1 0 0
Four Oaks Spraying Machine Co. (Ltd.)	Four Oaks Works, Sutton Coldfield	1 0 0
Fowler & de la Perrelle	Porter's Lane, Southampton	1 0 0
†Fowler, G.	Claremont, Taunton	..
Fowler, J. & Co. (Ltd.)	Leeds	1 0 0
Fox, Brothers & Co.	Wellington, Somerset	1 1 0
Fox, C. L.	Rumwell Hall, Taunton	1 0 0
Fox, Mrs. A.	Brislington House, near Bristol	1 0 0
†Fox, Robert	Grove Hill, Falmouth	..
Fox, R. A.	Yate House, Yate, Glos.	1 1 0
Foxcroft, C. T.	Hinton Charterhouse, Bath	1 1 0
*Fremlin, W. T.	Milgate Park, Maidstone	2 0 0
Fry, A.	8, Zion Hill, Clifton, Bristol	1 0 0
Fry, H. A.	19, Monmouth Place, Bath	1 1 0

Name.	Residence.	Subscriptions. £	s.	d.
*Fry, J. F.	Ford Abbey, Chard	2	0	0
*Fry, J. S. & Sons (Ltd.)	Union Street, Bristol	2	2	0
†Fuller, G. Pargiter	Neston Park, Corsham	..		
Fuller, S. and A.	Bath	1	0	0
Fursdon, E. S.	Hevers, Mont le Grand, Heavitree, Exeter	1	1	0
Gardiner, Sons & Co.	Nelson Street, Bristol	1	1	0
Garne, W.	Aldsworth, Northleach	1	1	0
Garne, W. T.	Aldsworth, Northleach	1	1	0
*Garratt, Lt.-Col. T. A. T.	Bishop's Court, Exeter	2	2	0
Garrett, W.	Backwell Hill House, West Town, R.S.O., Somerset	1	0	0
Garton, Jas.	Clarendon Park, Salisbury	1	0	0
Gear, W. H.	Bridge Street, Bath	1	1	0
*†George, William E., J.P.	Downside, Stoke Bishop, Bristol	..		
Gibbins, T.	Glynfelin, Neath	1	1	0
†Gibbons, H.	Church Farm, Clutton, Bristol	..		
Gibbons, P., J.P.	Keynsham	1	1	0
Gibbs, A. H.	Pytte, Clyst St. George, Topsham, Devon	1	0	0
*†Gibbs, G. A., M.P.	Tyntesfield, Bristol	..		
†Gibbs, H. M.	Barrow Court, Flax Bourton, Bristol	..		
Gibson, J. T.	Claverham, near Yatton	1	1	0
Gill, P. O.	Uplands, Wrington, Somerset	1	0	0
Gillingham, J. and Son	Prospect House, Chard	1	0	0
†Gladstone, J.	Bowden Park, Chippenham	..		
Glencross, T.	The Loose Box, Weston-super-Mare	1	0	0
Glyn, R. F.	The Cross House, Fontmell Magna, Shaftesbury	1	0	0
*Glyn, Sir Richard G., Bart.	Gaunt's House, Wimborne	2	2	0
†Godman, C. B.	Woldringfold, Horsham	..		
Godman, J.	The Raswells, Hascombe, Godalming	1	0	0
†Goldney, Sir Prior, Bart., C.B.	Derriads, Chippenham	..		
Gomer, W.	Killerton Estate Office, Broadclyst, Exeter	1	0	0
Goodden, J. R. P.	Compton House, Sherborne	1	0	0
Goodman, A. & Co.	3, Hammett Street, Taunton, and Broad Street House, London, E.C.	1	0	0
Gordon, G. H.	The Barn House, Sherborne	1	0	0
Goring, C.	Wiston Park, Steyning	1	0	0
†Gorringe, Hugh	Kingston-by-Sea, Brighton	..		
Grace, A.	39, Welsh Back, Bristol	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Grant, C. E.	Bursar, King's College, Cambridge.	1	0	0
Grant, W. J.	Pentonville, Newport, Mon. . .	1	0	0
Gray, R.	The Estate Office, Sherborne .	1	0	0
Greaves, R. M. . . .	Wern, Portmadoc, North Wales .	1	0	0
†Greenall, Mrs. C. E. . .	The Manor, Carlton Scroop, Grantham	..		
†Greenall, Sir G., Bart. .	Walton Hall, Warrington . .	..		
Greenslade, W. R. J. . .	Fairfield, Trull, Taunton . .	1	0	0
Greenway, W. . . .	Halse, Taunton	1	0	0
Greenwell, Sir W., Bart. .	Marden Park, Woldingham, Surrey	1	0	0
Greenwood, J. C. . . .	Claverton Down, Bath . .	1	0	0
Gregor, T.	11, Sketty Road, Swansea . .	1	0	0
Gregory, W.	Wellington, Somerset . . .	1	0	0
†Guest, Lady Theodora .	Inwood, Templecombe. . .	..		
Guille, H. C. de Stevens .	St. George, Castel, Guernsey .	1	0	0
Guise, Sir W. F., Bart. .	Elmore Court, Gloucester . .	1	0	0
Gunther, C. E. . . .	Tongswood, Hawkhurst, Kent .	1	0	0
Habgood, G.	Harley Lodge, Wimborne . .	1	0	0
Hall, A. C.	The Manor, Great Rolbright, Chipping Norton . . .	1	0	0
*Hambleden, Viscount .	Greenlands, Henley-on-Thames .	5	0	0
†Hambro, Sir Everard A. .	Hayes Place, Beckenham, Kent .	..		
Hancock, Rev. Prebendary F.	The Priory, Dunster, Somerset .	1	0	0
Hancock, H. C. . . .	The Court, Milverton, Taunton .	1	0	0
Hancock, Mrs. R. D. . .	Halse, Taunton	1	0	0
Harbôttle, E.	Topsham	1	0	0
Harding, C.	Upton Grove, Tetbury . . .	1	0	0
Harding, R.	Fenswood Farm, Long Ashton, Bristol	1	0	0
Harpur, W.	Borough Engineer, Cardiff . .	1	0	0
Harris, C. & T. (Ltd.). .	Bacon Curers, Calne, Wilts . .	1	0	0
Harris, H.	Singleton Park Farm, Sketty, S.O., Glam.	1	0	0
Harris, J. M.	Chilvester Lodge, Calne, Wilts .	1	0	0
Harrison, D.	The Grove, Tenby . . .	1	0	0
Harrison, McGregor & Co. .	Leigh, Lancashire	1	0	0
Haversham, Lord . .	Trevina, Tintagel, Cornwall . .	1	0	0
Haward, T. W.. . . .	Brombil House, Margam, Port Talbot	1	1	0
Hawkins, A. W. Bailey .	Stagenhoe Park, Welwyn, Herts .	1	0	0
Hawkins, Mrs.	10, Portland Place, London, W. .	1	1	0
†Haydon, Lt.-Col. W. H. .	Maidford, Malmesbury, Wilts .	..		
Hayes, F. J.	West Pennard, Glastonbury . .	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Heathcoat-Amory, Sir I. M., Bart.	Hensleigh, Tiverton, Devon	1	0	0
†Henderson, A. N.	Street Ashton House, Lutterworth	..		
Heneage, Capt. R.N.	Parc le Breos, Penmaen, Glam.	1	0	0
Henry, Lt.-Col. F.	Elmstree, Tetbury	1	0	0
Hepple, E. M.	Camerton, near Bath	1	0	0
Herbert, Maj.-Gen. Sir Ivor, Bart., M.P.	Llanarth Court, Raglan, Mon.	1	0	0
Hesse, F. W.	Bloomfield House, Bloomfield Road, Bath	1	0	0
†Hewitt, G. Southby.	Day, Son & Hewitt, 22, Dorset Street, London, W.	..		
Higgins, B.	Millhouse Farm, Evercreech	0	10	0
Hignett, G.	Hodshill, South Stoke, Bath	1	0	0
†Hill, B. H.	Uphill, Weston-super-Mare	..		
Hill, H.	Paulton, near Bristol	1	1	0
Hill, V. T.	Mendip Lodge, Langford, Bristol	1	1	0
Hill, W. B.	342, Priestwood Road, Wolverhampton	1	0	0
Hippisley & Sons	Wells, Somerset	1	0	0
Hippisley, R. J. B.	Ston Easton Park, Bath	1	0	0
Hiscock, A.	Motcombe, Dorset	1	0	0
†Hoare, Sir H. H. A., Bart.	Stourhead, Zeals, S.O., Wilts.	..		
Hoare, H. C.	Stourhead, Bruton	1	0	0
*Hobhouse, Rt. Hon. H.	Hadspen House, Castle Cary.	2	0	0
†Hoddinott, S.	Worminster, Shepton Mallet	..		
Holland and Coombs	Bristol	1	0	0
Holt Needham, O. N.	Barton Court, Colwall, near Malvern	1	0	0
†Hooper, R. N.	Stanshawes Court, Chipping Sodbury	..		
†Hope, W. H. B.	Eastwood, East Harptree, Bristol	..		
Hopper, H. R.	Merryweather & Sons, Greenwich Road, London, S.E.	1	1	0
†Horner, Sir J. F. Fortescue	Mells Park, Frome	..		
Hornsby and Sons (Ltd.)	Grantham, Lincoln	1	0	0
Horton, Rev. Preb. Le G.	Wellow Vicarage, Bath	1	1	0
Hosegood, A. W.	Williton, Taunton	1	0	0
Hosegood, Obed., jun.	Dillington, Ilminster	0	10	0
†Hoskins, R. J.	Beard Hill, Shepton Mallet	..		
Hoskyns, H. W. P.	North Perrott Manor, Crewkerne, Somerset	1	0	0
Houldsworth, A. F.	Widcombe, Kingsbridge, Devon	1	1	0
Hudson, E. V.	Wolseley Works, Witton, Birmingham	1	0	0
†Hughes, A. E.	Wintercott, Leominster	..		
Humphries, Sidney	Eastfield Lodge, Westbury-on-Trym, Bristol	1	1	0
Hunter, Sir Charles, Bart., M.P.	1, West Eaton Place, London, S.W.	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
†Hurle J. C.	Brislington Hill, Bristol	..		
Hurst and Son	152, Houndsditch, London	1	0	0
Hussey, J. W.	Bouverie House, Exeter	1	0	0
†Hylton, Lord	Charlton, near Radstock	..		
Ibbotson, R.	The Hawthorns, Knowle, Warwickshire	1	0	0
*Ilchester, Earl of	Melbury, Dorchester	2	2	0
Imperial Live Stock Insurance Co.	17, Pall Mall, East, London, S.W.	1	0	0
Innes, G. P. Mitchell	Craig-yr-Haul, Castleton, Cardiff	1	0	0
International Harvester Co. (Ltd.)	80, Finsbury Pavement, London, E.C.	1	0	0
Ireland, A. C.	Brislington Hill, near Bristol	1	1	0
Irvine, H. O.	Southerndon, Bridgend, Glam.	1	0	0
*Islington, Lord	Hartham Park, Corsham	2	0	0
*Ismay, J. H.	Iwerne Minster, Blandford, Dorset	2	0	0
Jackman, Percy	Pulteney Hotel, Bath	1	0	0
Jackson, Sir H. M., Bart.	Llantillio Court, Abergavenny	1	0	0
James, S.	Ham Farm, Shepton Mallet	1	0	0
Jardine, E., M.P.	The Park, Nottingham	1	1	0
Jarmain, T. M.	Haseley Iron Works, Tetsworth	1	1	0
Jefferis, Mrs.	Harefield Hall, Willsbridge, Glos.	1	0	0
Jenkins, D.	Flemingston Court, Cowbridge, Glam.	1	0	0
Jenkins, E.	c/o F. Capern, Lewin's Mead, Bristol	1	0	0
Jenkins, Captain Vaughan	St. Winifreds, Combe Down, Bath	1	0	0
Jenkins, W. H. P.	Frenchay Park, Bristol	1	0	0
*Jersey, Earl of	Middleton Park, Bicester, Oxon	2	0	0
†Jervoise, Mrs. B. A. L.	Herriard Park, Basingstoke	..		
Jervoise, F. H. T.	Herriard Park, Basingstoke	1	1	0
Jeyes' Sanitary Compounds Company	Cannon Street, London, E.C.	1	0	0
John, E.	Cowbridge, Glamorgan	1	0	0
Johns, W. B.	25, Pargiter Road, Bearwood, near Birmingham	1	0	0
Jones, T. S.	Frondez, Radyr, Cardiff	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Keeling, G.	North Hill Farm, Dunkerton, Bath	1	0	0
Kekewich, T. H., J.P.	Peamore, Exeter	1	0	0
Kell & Co.	Gloucester	1	0	0
Kelly, Col. A. L.	Cadbury House, Wincanton, Somerset	1	0	0
Kelway, W.	Huish Episcopi, Langport	1	1	0
†Kemp, L. J.	Maer, Exmouth	..		
Kennaway, Rt. Hon. Sir J. H., Bart., M.P.	Escot, Ottery St. Mary	1	1	0
Kennaway, J.	Escot, Ottery St. Mary	1	0	0
*Keyser, C. E.	Aldermaston Court, Reading	2	0	0
Keyworth, J. and H. & Co.	Tarleton Street, Liverpool	1	0	0
King, J., M.P.	Sandhouse, Witley, Surrey	1	0	0
King and Sons, R.	Milsom Street, Bath	1	1	0
King, W. E. M.	Donhead Lodge, Salisbury	1	0	0
Kingwell, H. J.	Great Aish, South Brent, S. Devon	1	0	0
Knight, S. J.	Walnut Farm, East Dundry, near Bristol	1	0	0
†Knollys, C. R.	Weekley, Kettering	..		
Knox, E.	Kilmersdon, Bath	1	1	0
†Kruse, W.	Perran Bay House, Perranporth, Cornwall	..		

†Lake, C.	Oakley, Higham, Kent	..		
Lane, A. P.	Arthur's Club, St. James's, London	1	0	0
*Lansdowne, Marquis of	Bowood, Calne	2	0	0
Larkworthy, E. W.	Messrs. J. L. Larkworthy & Co., Worcester	1	0	0
†Latham, T.	Dorchester, Oxon	..		
Lawes, Algernon (Ltd.)	203, Hornsey Road, London, N.	1	1	0
Lear, F. G.	The Reddings, nr. Cheltenham	1	0	0
Lear, H. H.	His Grace the Duke of Marlborough's Farm, Woodstock, Oxon.	1	0	0
Lee, Major-Gen. H. H.	The Mount, Dinas Powis, Cardiff	1	0	0
Leeder, E. H.	Mount Pleasant House, Swansea	1	0	0
Legard, A. G.	Brow Hill, Batheaston, Bath	1	0	0
Lennard, Sir H., Bart.	Wickham Court, West Wickham, Kent	1	0	0
Lethbridge, Charles	Carlton Club, London, S.W	1	0	0
Leverton, W. A.	Columb John Farm, Stoke Canon, Exeter	1	0	0

Name.	Residence.	£	s.	d.
Leverton, W.	Woolleigh Barton, Beaford, North Devon	0	10	0
Lewis, Col. H.	Green Meadow, near Cardiff	1	1	0
Lewis, Wm. and Son (Ltd.)	*Herald* Office, Bath	1	0	0
†Ley, John Henry	Trehill, Exeter	..		
†Leyland, C. J.	Haggerston Castle, Beal, Northumberland	..		
Liddell, C. O.	Shire Newton Hall, Chepstow	1	1	0
Liddon, E., M.D.	Silver Street House, Taunton	1	0	0
Linton, E. N.	Westgate Chambers, Newport, Mon.	1	0	0
Lipscomb, Godfrey	Margam Park, Port Talbot	1	0	0
Lister, R. A. & Co. (Ltd.)	Dursley, Glos.	1	1	0
†Lister, J. J.	Warninglid Grange, Haywards Heath	..		
Llewellyn, Lieut.-Col. A.	Writtenhall, Bewdley, Worcestershire	1	0	0
Llewellyn Llewellyn, T. E.	Hackwood, Basingstoke	1	1	0
*Llewelyn, Sir J. T. D., Bart.	Penllergaer, Swansea	2	2	0
Lloyd, J. C.	Dinas, Brecon	1	0	0
*†Long, Rt. Hon. Walter H., M.P.	Rood Ashton, Trowbridge	..		
Long, Col. William	Woodlands, Congresbury, Somerset	1	0	0
Long, W. F.	New Barnes Farm, Bromyard	1	0	0
Longrigg, G. E.	Weston Lea, Bath	1	0	0
Lopes, Sir H. Y. Buller, Bart.	Maristow, Roborough, Devon	1	0	0
Loram, Brothers	Cathedral Dairy, Exeter	1	1	0
Lovelace, T.	Bratton Court, Minehead, Somerset	1	0	0
Lubbock, Major G.	Greenhill, Warminster, Wilts	1	0	0
Lucas, Lord	West Park, Ampthill	1	0	0
†Lutley, J. H.	Brockampton, Worcester	..		
Luttrell, Capt. A. F.	Court House, East Quantoxhead, Bridgwater	1	0	0
Luttrell, Claude M. F.	15, Gay Street, Bath	1	1	0

McCalmont, Major D. H. B.	Crockford's Hall, Newmarket	1	1	0
Macdonald, H. L. S.	Avondale, Bathford, Bath	1	0	0
Macdonald, K.	5, Sion Hill, Bath	1	0	0
McIntosh, Mrs. C. M.	Havering Park, Havering Atte Bower, Essex	1	1	0
Major, H. J. and C. (Ltd.)	Bridgwater	1	0	0
†Mansell, A. E.	Mount Vernon, Melton Mowbray, Tasmania	..		
Marcus, M.	High Trees, Redhill, Surrey	1	0	0

Name.	Residence.	£	s.	d.
Marfell, R. H.	Great House Farm, Llangeview, Usk	1	0	0
Marken, E. R.	Henstaff Court, Pontyclun, R.S.O.	1	1	0
Marshall, L. H.	Chippenham	1	0	0
Marshall, Sons & Co. (Ltd.)	Britannia Iron Works, Gainsborough	1	0	0
Martin, E. G. Bromley	Ham Court, Upton-on-Severn	1	0	0
Martin, J.	Thorverton, R.S.O., Devon	1	0	0
Martin, L. J. (Associated Manufacturers' Assn.)	72-80, Mansell Street, Aldgate, London, E.C.	1	0	0
Martin and Carnes	Taunton	1	1	0
Martyn, G.	Tremeddan, Liskeard, Cornwall	1	1	0
Mason, F. F.	Swansea	1	0	0
Massey-Harris Co. (Ltd.), (C. W. Dawkins, General Manager)	54 & 55, Bunhill Row, London, E.C.	1	0	0
Masters, A.	29, St. Mary Street, Cardiff	1	0	0
Mathews, Ernest	Little Shardeloes, Amersham, Bucks	1	0	0
Mathews, E. R. Norris, F.R.Hist. Soc.	Central Library, Bristol	1	0	0
Matthews, Adam	The Cornhill Stud, Swansea	1	0	0
Matthews, David	Llwyneryr, Morriston, Glam.	1	0	0
Matthews, L. B.	Milton, Gillingham, Dorset	1	0	0
Maule, Major-Gen. H. B.	2, Penn Lea Road, Newbridge Hill, Bath	1	0	0
Maule, M. St. John	Chapel House, Bath	1	0	0
May, A. C.	Avon House, Stoke Bishop, Bristol	1	0	0
Meade-King, W. O.	Walford House, Taunton	1	0	0
Meager, F. F.	Melbourne House, Swansea	1	0	0
Meddick, William G.	11, Great Stanhope Street, Bath	1	0	0
Membery, R.	37, Southgate Street, Bath	1	0	0
Merry, Richard	Goulds, Broadclyst, Exeter	0	10	0
Merryweather, J. C.	4, Whitehall Court, London, S.W.	1	0	0
Methuen, General Lord, C.B., C.M.G.	Corsham Court, Wilts	1	0	0
Miers, R. H. P.	Clydach-on-Tawe, Glam.	1	0	0
Mildmay, Capt. C. B. St. J.	Hallam, Dulverton	1	0	0
†Mildred, G. B.	Newington House, Craven Arms, Shropshire	..		
Millbank, Sir Powlett C. J., Bart.	Norton Manor, Presteign	1	0	0
Miller, T. H.	St. Albans, Weston Park, Bath	1	0	0
Miller-Hallett, A.	Goddington, Chelsfield, Kent	1	1	0
Mills, B. W.	31, Cambridge Place, Paddington, London, W.	1	0	0
Mitchell, A. C.	Highgrove, Tetbury	1	0	0
Molassine Co. (Ltd.)	East Greenwich, London, S.E.	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Moody, C.	Maisemoor, Evercreech	1	0	0
Moore-Gwyn, J. E.	Duffryn, Neath, Glamorgan	1	0	0
†Moore, H. F.	Renée House, 48, Dulwich Road, Herne Hill, S.E.	..		
Moore, Sir Newton J., K.C.M.G.	Savoy House, Strand, London, W.C.	1	1	0
Moore-Stevens, Col. R. A.	Winscott, Torrington, Devon	1	0	0
Morant, Mrs. E.	Brokenhurst Park, Hants	1	0	0
Morel, C. E.	. . . .	1	0	0
*Moreton, Lord	Sarsden Lodge, Chipping Norton	2	2	0
*Morgan, T.	Capital and Counties Bank Buildings, Taff Street, Pontypridd	2	2	0
Morgan, W. A.	Winthankley, St. Andrew's, Fife	1	1	0
*Morley, Earl of	Saltram, Plympton, Devon	2	0	0
Morley, Charles	Shockerwick, Bath	1	1	0
*Morris, C.	Highfield Hall, St. Albans	2	0	0
Morris and Griffin (Ltd.)	Maindee, Newport, Mon.	1	1	0
Morris, Sir R. A., Bart.	Sketty Park, Swansea	1	0	0
Morris, Son and Peard	Auctioneers, North Curry, Taunton	1	0	0
Morrison, Captain J. A.	Berwick House, Hindon, Salisbury	1	0	0
†Morrison, J. A.	Basildon Park, Reading	..		
*Mount-Edgcumbe, Earl of	Mount Edgcumbe, Devonport	2	2	0
†Mucklow, E., J.P.	Woodhill, Bury, Lancashire	..		
M ller, Jansen	Newport, Mon.	1	0	0
Munn, F.	Dumballs Road, Cardiff	1	0	0
Muntz, F. E.	Umberslade, Hockley Heath, Warwickshire	1	0	0
Muntz, J. O.	Goodameavy, Yelverton	1	0	0
Murray-Anderdon, H. Edwd.	Henlade House, Taunton	1	1	0

Napier, H. B.	Ashton Court Estate Office, Long Ashton, Bristol	1	1	0
Neal, J. F.	Kingsdon, Taunton	1	0	0
Neeld, Sir A. D., Bart., C.B.	Grittleton, Chippenham	1	0	0
Nelder, C. W.	Carnarvon Arms, Dulverton, Somerset	0	10	0
†Neville-Grenville, Robert	Butleigh Court, Glastonbury	..		
New, H. G.	Craddock, Cullompton, Devon	1	0	0
Newington, C.	Oakover, Ticehurst, Sussex	1	0	0
Newman, Sir R. H. S. D. L., Bart.	Mamhead Park, near Exeter	1	1	0
Nicholetts, E. C.	The Lons, Bitton, Gloucestershire	1	0	0
Nichols, G.	49, Broad Street, Bristol	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Nitrogen Fertilisers (Ltd.) .	Winchester House, Old Bond Street, London, E.C.	1	0	0
Nix, J.	Tilgate, Crawley, Sussex . .	1	1	0
Nixon, W. . . .	The University, Bristol . .	1	0	0
*Normanton, Earl of . .	Somerley, Ringwood . . .	2	0	0
North, G. F. . . .	Stratfield Saye, Mortimer, R.S.O., Berks.	1	0	0
*Northumberland, Duke of	Albury Park, Guildford . .	5	0	0
Oakey, G. . . .	Brittleware Farm, Charlwood, Surrey	1	0	0
Oakley, H. E. . . .	Dewstow, near Chepstow . .	1	0	0
†O'Hagan, Lord . .	Pyrgo Park, Havering Atte Bower, Romford, Essex . . .		..	
O'Halloran, Miss P. . .	Fairwood Lodge, Killay, R.S.O., Glam.	1	0	0
Olver, J. C. . . .	Woodland Valley, Ladock, Cornwall	1	0	0
Osborne, J. . . .	9, Clifton Park, Clifton . . .	1	1	0
Osmond and Son . .	Grimsby	1	0	0
Paget, A. B. . . .	Bathwick Estate Office, 100, Sydney Place, Bath. . .	1	0	0
Paget, L. C. . . .	Middlethorpe Hall, Yorks . .	1	0	0
*Paget, Sir Richard, Bart. .	9, King's Bench Walk, Temple, London	2	0	0
Palmer, G. Ll. . . .	Lackham, Lacock, Wilts . .	1	0	0
†Palmer, R. . . .	Lodge Farm, Nazeing, Waltham Cross, Essex		..	
Palmer, W. H. . .	York Buildings, Bridgwater . .	1	0	0
†Parker, Hon. Cecil T. .	The Grove, Corsham, Wilts . .		..	
Parker, F. J. . . .	Plymouth Street, Swansea . .	1	0	0
Parmiter, P. J. & Co. .	Tisbury, Wilts	1	0	0
Parry-Okeden, Lieut.-Col. U. E. P.	Turnworth, Blandford . . .	1	0	0
†Parsons, J. D. Toogood, jun.	Manor View, Rusthall, Tunbridge Wells		..	
†Parsons, R. M. P. . .	Misterton, Crewkerne . . .		..	
Pass, A. D. . . .	Manor House, Wootton Fitzpaine, Charmouth, Dorset . . .	1	0	0

Name.	Residence.	Subscriptions. £	s.	d.
Peacock, W.	3, Buckingham Gate, London	1	1	0
Pearce, S. & Co.	46a, Market Street, Manchester	1	0	0
Pearse, T. C.	Leigh Farm, Dulverton	1	0	0
Peel, Viscount	52, Grosvenor Street, London, W.	1	1	0
Pember, G. H.	. . . .	1	0	0
Penberthy, Professor J.	Dean Hall, Newnham, Glos.	1	0	0
Pendarves, W. Cole	Pendarves, Camborne, Cornwall	1	1	0
Perkins, Col. E. K.	Shales, Bitterne, Hants	1	1	0
†Perry-Herrick, Mrs.	Beau Manor Park, Loughborough	..		
Petherick, R., jun.	Acland Barton, Landkey, Barnstaple	0	10	0
Petters (Ltd.)	Yeovil	1	0	0
Pettifer, T. & Co.	Eydon, Banbury	1	0	0
Phillips, F.	Nantcoch, Newport, Mon.	1	1	0
Phillips, G.	The Gaer, Newport, Mon.	1	0	0
Phillips, J.	Messrs. J. Phillips & Co., Bath	1	0	0
Phillips, J. F. Lort	. . . .	1	0	0
Phillips, L. R.	. . . .	1	1	0
Piggott, Brothers & Co.	59, Bishopsgate Street Without, London, E. C.	1	0	0
Pike, C. A.	Chilean Nitrate Committee, Friar's House, 39-41, New Broad Street, London, E.C.	1	0	0
†Pinney, R. W. P.	Sutton Veny, Warminster	..		
†Pitt, W.	South Stoke House, Bath	..		
Plaister, C.	Church Farm, Monkton Combe, Bath	1	0	0
Plumptre, H. F.	Goodnestone, Dover	1	0	0
*Plymouth, Earl of	Hewell Grange, Bromsgrove	4	0	0
*Poltimore, Lord	Poltimore Park, Exeter	3	3	0
Poole, Mrs. A. R.	King's Hill, Dursley	1	1	0
Pope, Alfred	Dorchester	1	0	0
Pope, John	Nowers, Wellington, Somerset	1	0	0
Pope, S. P.	Howden, Tiverton, N. Devon	1	1	0
Popham, H. L.	Hunstrete House, Pensford, Bristol	1	0	0
Porter, W. J. H.	Glendale Farm, Wedmore	1	0	0
†Portman, Hon. C. B.	Goldicote, Stratford-on-Avon	..		
Portman, Hon. Mrs. C. B.	Goldicote, Stratford-on-Avon	1	0	0
*Portman, Viscount	Bryanston, Blandford	5	0	0
Price, Owen	Nantyrharn, Cray, Brecon	1	0	0
Prichard, H. L.	Penmaen, R.S.O., Glam.	1	1	0
Pritchard, D. F., J.P.	Crumlin Hall, Crumlin, Mon.	1	1	0
Proctor, H. and T. (Ltd.)	Cathay, Bristol	1	1	0
Pullen, James	Lapdown Farm, Tormarton, Gloucester	1	0	0
†Purgold, A. D.	Ebna Lodge, Gobowen, Salop	..		

Name.	Residence.	Subscriptions. £ s. d.
Quantock Vale Cider Co.	North Petherton, Bridgwater	1 0 0
Quested, J. E.	The Firs, Cheriton, Kent	1 0 0
*†Radnor, Earl of	Longford Castle, Salisbury	..
†Ransome, B. C.	Orwell Works, Ipswich	..
Rawlence, Ernest A.	Newlands, Salisbury	1 0 0
Rawlence, G. Norman	7, Moberley Road, Salisbury	1 0 0
Read, B.	Church Farm, Cam, Dursley, Gloucester	1 0 0
Rees, W. J.	The Laurels, Swansea	1 1 0
Reeves, Robert and John, and Son	Bratton Iron Works, Westbury, Wilts	1 0 0
Remnant J. F., M.P.	The Grange, Hare Hatch, Twyford	1 0 0
Rhondda, Lord	Llanwern, Newport, Mon.	1 0 0
Rice, Rees	Velindre, Morriston, Glam.	0 10 0
Richardson, Rev. A.	Bath and County Club, Bath	1 0 0
Riley, J. L. & A.	The Iwerne, near Ledbury	1 0 0
Robins, J.	High Bray, South Molton	0 10 0
Robins, T.	Gratton Barton, High Bray, South Molton	1 0 0
Robinson, E. S. & A. (Ltd.)	Redcliffe Street, Bristol	1 1 0
Robinson, John & Co.	Bristol	1 1 0
Roe, W. J.	West Pennard, Glastonbury	1 0 0
Rogers, E. P.	Burncoose, Perranwell, Cornwall	1 0 0
Rogerson, R. W.	Ward and Co., Northgate Street, Bath	1 0 0
Rolleston, S. V.	Saltford House, Saltford, Bristol	1 0 0
Rolleston, Col. V., J. P.	Saltford House, near Bristol	1 1 0
*Roundway, Lord	Roundway Park, Devizes	2 2 0
Rouse-Boughton, Sir W. St. A., Bart.	Downton Hall, Ludlow	1 0 0
Rouse-Boughton, Lady	Downton Hall, Ludlow	1 0 0
Rowden, A. Roger	Hill End, Eastnor, Ledbury	1 0 0
Rowliffe, E. L.	Hall Place, Cranleigh, Guildford	1 1 0
Royal Guernsey Agricultural and Horticultural Society	Guernsey	1 0 0
Ruston, Proctor & Co. (Ltd.)	Lincoln	1 0 0
Rutherford, J. A.	Highclere Estate Office, Newbury, Berks	1 0 0
Saillard, P.	Buchan Hill, Crawley, Sussex	1 0 0
St. Audries, Lord	St. Audries, Bridgwater	1 1 0

Name.	Residence.	Subscriptions. £	s.	d.
*St. Germans, Earl of	St. Germans, Cornwall	2	0	0
†Salmon, H. C.	North Field, Bridgwater	..		
Salter, Benjamin	Newlands, Broadclyst, Exeter	1	0	0
Salter, T.	Beare Farm, Broadclyst, Exeter	1	0	0
Samuel, A.	74, Mansel Terrace, Swansea	1	0	0
Samuelson, Ernest	Bodicote Grange, Banbury	1	1	0
Sanders, R. A., M.P.	Barwick House, Yeovil	1	0	0
Sandys, Capt. G. J., M.P.	Hatherleigh House, Weston-super-Mare	1	1	0
Sanford, H. S. J. A.	The Court House, Middlehill, Broadway, Worcestershire	1	0	0
Sankey, R. I.	Queen Anne Mansions, St. James's Park, London, S.W.	1	0	0
†Scott, T.	. . . .	..		
†Seaton, Lord	Beechwood, Plympton, Devon	..		
Sedgwick, T. E.	26, Oriental Street, Poplar, London, E.	1	1	0
Senior and Godwin	Auctioneers, Sturminster Newton, Dorset	1	1	0
†Shaw-Stewart, Walter R.	Hayes, Shaftesbury	..		
Shatford, F.	Bosmore Farm, Henley-on-Thames	1	0	0
*Shelley, Sir John, Bart.	Shobrooke Park, Crediton	2	2	0
Shelley, Capt. J. F.	Posbury House, near Crediton	1	0	0
Sheppard, P. C. O.	Dunraven Estate Office, Bridgend, Glam.	1	1	0
†Sherston, C. J. T.	Harewood, Leeds	..		
*Sidmouth, Viscount	Upottery Manor, Honiton	2	0	0
Sillifant, A. O.	Culm Leigh, Stoke Canon, Exeter	1	0	0
Simonds, L. de L.	Audley's Wood, Basingstoke	1	1	0
*Simpson, Charles (Hewthorn & Co.)	Walton Lodge, Broxbourne, Herts	2	0	0
Simpson, F. C.	Maypool, Churston Ferrers, R.S.O., S. Devon	1	0	0
*Singer, W. M. G.	42, Charles Street, Berkeley Square, London, W.	2	0	0
Skinner, G. C.	Pound, Bishops Lydeard	1	0	0
Skyrme, J. H.	Madley, Hereford	1	0	0
Slatter, J.	Paxford, Campden, S.O., Glos.	1	0	0
Smail, J. I.	Warren Wood, Hayes, Kent	1	1	0
Smart, G. E.	Combe Hay Manor, Bath	1	1	0
Smith, A. J.	Brooklea, St. Anne's Park, Bristol	1	0	0
Smith, F. Barry	Burnewith, The Friars, Canterbury	1	0	0
Smith, C. C. F.	Perfect Dairy Machines (Ltd.), 105, Middle Abbey Street, Dublin	1	0	0
Smith, Bros. & Co. (Ltd.)	Westgate Buildings, Bath	1	0	0
Smith, J.	Monkton, Hereford	1	0	0
†Smith, J. W.	Thinghill Court, Hereford	..		
Smith, Hon. Mrs. Murray	Gumley Hall, Market Harborough	1	0	0
†Smith, S. Lee	Larkfield, Maidstone	..		

Name.	Residence.	£	s.	d.
Smith-Barry, J. H.	Stowell Park, Pewsey, Wilts.	1	0	0
Smyth, Hon. G. N.	Ashton Court, Bristol	1	0	0
Smyth, P.	Broford, Dulverton	1	0	0
Smyth-Richards, G. C.	Filleigh Lodge, South Molton	1	0	0
Snow, Major A. D.	Wall Tyning, Bitton, nr. Bristol	1	1	0
*Somerset, Duke of	Maiden Bradley, Bath	2	0	0
Somerset Trading Co. (Ltd.)	Bridgwater	1	1	0
†Somerville, A. F.	Dinder House, Wells, Somerset		..	
Southwood, J. W.	1, St. Peter's Terrace, Twerton, Bath	1	0	0
Spear Brothers and Clark (Ltd.)	Southgate Street, Bath	1	0	0
†Spearman, Sir J. L. E., Bart.	. . . .		..	
Spencer, F.	Pondsmead, Oakhill, Bath	1	1	0
Spencer, W. C.	Manor Farm, Hillfield, Cattistock, Dorset	1	0	0
Spicer, Capt.	Spye Park, Chippenham	1	0	0
Spicer, Lady M.	Spye Park, Chippenham	1	0	0
*Spillers and Bakers (Ltd.)	Cardiff	2	0	0
Spratts' Patent (Ltd.)	24 and 25, Fenchurch Street, City, London, E.C.	1	0	0
*†Stanley, E. A. V.	. . . .		..	
Stephens, H. C.	Avenue House, Finchley, N.	1	0	0
Stevens, R. N.	Woodham Hall, Woking, Surrey	1	0	0
Stephenson, R. E. W.	Tue Brook, Liverpool	1	0	0
Steward, Major R. H.	Freshford, near Bath	1	0	0
Stewart, Rev. H. J.	The Vicarage, Cockett, Glam.	1	0	0
Stilgoe H. W.	The Grounds, Adderbury, near Banbury, Oxon	1	0	0
Stoddart, F.	Manor House, Walton, Clevedon	1	1	0
Stoffell, W. M.	11, Cavendish Place, Bath	1	1	0
Stokes, C. W. Rees	Town Clerk, Tenby	1	1	0
Stooke, J.	Sherford, Brixton, Plymouth	1	0	0
Storrar, J. I.	Hamilton Estate Office, The Palace, Hamilton	1	0	0
Stothert, P. K.	Bradford-on-Avon, Wilts	1	0	0
†Strachie, Lord	Sutton Court, Pensford, Somerset		..	
Strangways, Hon. H. B. T.	Shapwick, Bridgwater	1	0	0
Stratton, Richard	The Duffryn, Newport, Mon.	1	0	0
Stride, T.	Stanley House, Camden Road, Bath	1	0	0
Strode, G. S. S.	Newnham Park, Plympton	1	0	0
Stucley, H. V. G.	Pillhead, Bideford, North Devon	1	0	0
Studdy, T. E.	Mazonet, Stoke Gabriel, Totnes	1	0	0
Studley, J. Im.	Toller Fratrum, Maiden Newton	1	0	0
*Sutton, E. P. F.	Sidmouth Grange, near Reading	2	2	0
*Sutton and Sons	Seedsmen, Reading	2	2	0
Swansea, Lord	Singleton, Swansea	1	1	0
Swanwick, Bruce	R. A. College Farm, Cirencester	1	0	0
Symons J. & Co. (Ltd.)	The Plains, Totnes	1	1	0

Name.	Residence.	Subscriptions. £	s.	d.
Talbot, Miss	Margam Park, Port Talbot	1	0	0
Tamlin, W.	Talbot House, Stanley Road, Teddington, Middlesex	1	0	0
Tangyes (Ltd.)	Cornwall Works, Birmingham	1	0	0
Tanner, H.	Westgate Buildings, Bath	1	0	0
Tapp, David James	Knaplock, Winsford, Dulverton	1	0	0
Tapp, J. A.	Knaplock, Dulverton	1	0	0
Tasker W. & Sons (Ltd.)	Waterloo Ironworks, Andover	1	1	0
Tate, J. A.	Fairfield, Wells, Somerset	1	0	0
Tatem, W. J.	The Court, St. Fagan's, Glam.	1	0	0
Taverner, G. E.	Budlake, Devon	1	0	0
Taylor, A. H. W.	8, New Bond Street, Bath	1	0	0
†Taylor, George	Cranford, Hounslow, W.		..	
Taylor, H. W.	Showle Court, Ledbury, Hereford	1	0	0
†Tazewell, W. H.	Manor House, Taunton		..	
*Temple, Earl	Newton St. Loe, Bristol	2	2	0
Templeman, G. D.	Hambridge, Curry Rivell, Taunton	1	0	0
Thomas, Sir Griffith	Court Herbert, Neath	1	0	0
Thomas, I.	Ely Farm, Cardiff	1	0	0
Thomas, J.	Velindre, Kidwelly, Carmarthenshire	1	1	0
Thomas, J. A.	Dolgoy, West Cross, R.S.O., Glam.	1	0	0
Thomas-Stanford, C.	Preston Manor, Brighton	1	0	0
Thomas, W. Meyler	Ynysplwm, Llantrissant	1	0	0
Thomas & Evans & John Dyer (Ltd.)	Swansea	1	0	0
Thompson, C. E.	Camerton, Bath	1	1	0
Thorley, J.	Wood Hall, Shenley, Herts	1	0	0
Thorne, J. G.	Horridge, Romansleigh, S. Molton	0	10	0
Thornton, W. A.	Lock, Partridge Green, Sussex	1	0	0
Thresher, E. B.	Corfe Hill, Weymouth	1	0	0
Thurlow, G. R.	Stowmarket	1	0	0
*Thynne, Lord A., M.P.	15, Manchester Square, London	2	0	0
Tidswell, R. J.	Haresfield Court, Stonehouse, Glos.	1	0	0
Tillard, Rear-Admiral P. F.	Alford House, Castle Cary	1	0	0
Tilley, W. T. S.	East Compton, Shepton Mallet	1	0	0
Timmins, T. B.	24, Green Park, Bath	1	0	0
Tipper, B. C., and Son	Balsall Heath, Birmingham	1	0	0
Titt, J. W.	Implement Works, Warminster	1	0	0
Toogood, E. K.	Messrs. Toogood & Sons, Southampton	1	0	0
Tory, Randolph	Charisworth, Blandford	1	0	0
Trafford, G. R.	Hill Court, Ross, Herefordshire	1	1	0
*Tredegar, Viscount	Tredegar Park, Newport, Mon.	2	2	0
Treffry, I. de C.	Penarwyn, Par Station	1	1	0
Trelawney, J. S.	Harewood, Buckfastleigh, Devon	1	0	0
†Tremaine, W. H.	Sherborne, Northleach, Glos.		..	
Tremayne, Capt. W. F.	Carclews, Perran ar Worthal, Truro	1	1	0

Name.	Residence.	Subscriptions. £ s. d.
Tremayne, Hon. Mrs.	Sydenham, Lewdown, R.S.O., N. Devon	1 0 0
Troup, Alan C.	Doddean, Salisbury	1 0 0
Troyte, H.	Huntsham Court, Bampton, Devon	1 0 0
Troyte, Major H. A.	Slindon, Arundel, Sussex	1 0 0
Trump, W.	Borough Farm, Broadclyst, Exeter	1 0 0
Tucker, H.	Sutton Montis, Sparkford, Bath	1 0 0
Tucker, M. & Co.	Broad Quay, Bath	1 0 0
†Tudway, C. C.	The Cedars, Wells, Somerset	..
Turner Brothers	Milsom Street, Bath	1 0 0
Turnor, Lt.-Col. W. W.	Pinkney Park, Chippenham	1 0 0
Unite, John (Ltd.)	291, Edgware Road, London	1 0 0
Unwin, L.	Tiverton	1 0 0
†Vacher, E. P.	Cowfold Lodge, Cowfold, Sussex	..
Valletort, Viscount	Mount Edgcumbe, Devonport	1 1 0
Vaughan, Rev. Preb.	The Rectory, Wraxall, Somerset	1 0 0
Vaughan, W. I.	9, Queen's Place, Cardiff	1 0 0
Veitch, P.	Exeter	1 0 0
†Verulam, Earl of	Gorhambury, St. Albans	..
Vine & Co. (Ltd.)	Cornhill Chambers, Swansea.	1 1 0
Vivian, Miss	Clyne, Blackpyl, S. Wales	1 1 0
Vivian, Hon. Odo	Sketty, Swansea	1 0 0
Waide, W. and Sons	Churn Works, Leeds	1 0 0
Wainwright, Donald	Summerleaze, Shepton Mallet	1 1 0
Waldegrave, Earl	Chewton Priory, Somerset	1 0 0
*Waleran, Lord	44, Hans Mansions, London, S.W.	2 0 0
Walker, E. G. F.	The Hollies, Chew Stoke, Bristol	0 10 0
Walker, H.	Beach, Bitton, Glos.	1 0 0
Wallis and Stevens	North Hants Iron Works, Basingstoke	1 0 0
Wallop, Hon. J.	Barton House, Morchard Bishop, Devon	1 0 0
Walrond, Hon. Mrs. C. M. L.	Bradfield, Cullompton	1 1 0

Name.	Residence.	Subscriptions. £ s. d.
†Walsingham, Lord . .	Merton Hall, Thetford, Norfolk	..
Ward, J. E. . . .	Red Lodge, Purton, Wilts . . .	1 0 0
Ward, R. B. . . .	Westwood Park, Droitwich . .	1 0 0
Wardlaw, H. and A. . .	Holway Farm, Sherborne . .	1 0 0
†Waring, C. E. . . .	Conservative Club, Cardiff . .	..
Waring, H. F. . . .	Farningham Hill, Farningham, Kent	1 0 0
Warne, J. . . .	Tregenhayne, Tregony, Grampound Road, Cornwall . . .	1 0 0
Warne, T. . . .	Trevisquite Manor, St. Mabyn, R.S.O.	1 0 0
†Warner, T. C. . . .	Bretterham Park, Suffolk . .	..
Waterloo Mills Cake and Warehousing Co. (Ltd.) .	Wilmington, Hull . . .	1 0 0
Watson, H. R. . . .	Purse Caundle, Sherborne . .	1 0 0
Watson, T. E. . . .	St. Mary's Lodge, Newport, Mon. .	1 0 0
Watson, Hon. T. H. .	Cormiston, Milverton, Somerset .	1 0 0
Watts, J.	Backwell, near Bristol . . .	1 0 0
*Way, General N. S. . .	Manor House, Henbury, Bristol .	2 0 0
Weaver & Co. . . .	Beaufort Warehouses, Swansea .	1 0 0
Webb, E. and Sons . .	Wordsley, Stourbridge . . .	1 0 0
Webb, H., M.P. . .	Llwynarthen, Cardiff . . .	1 0 0
Weech, J. and Sons . .	Maudlin Street, Bristol . .	1 0 0
Welch-Thornton, H. . .	Beaurepaire, Basingstoke . .	1 1 0
Were, J. Kennet . .	Sidmouth	1 1 0
Wernher, Lady . . .	Luton Hoo, Luton . . .	1 1 0
Wessex Associated News (Ltd.)	Westgate Street, Bath . .	1 0 0
Westminster, Duke of. .	Eaton Hall, Chester . . .	1 1 0
Weston, H. and Sons .	The Bounds, Much Marcle, *via* Dymock, Herefordshire . .	1 0 0
†White, A. R. . . .	Charnage, Mere, Wilts . . .	..
White, F. . . .	Torweston, Williton . . .	1 0 0
White, W. J. S. . .	Zeals Park, Wiltshire . . .	1 0 0
Whitley, S. R. . .	Rookwood, Shinfield, Reading .	1 0 0
Whitley, W. and H. . .	Primley Farm, Paignton . .	1 0 0
Whitting, C. E. . . .	Uphill Grange, Weston-super-Mare	1 1 0
Whittuck, E. A. . .	Claverton Manor, Bath . .	1 1 0
Wilder, J. . . .	Yield Hall Foundry, Reading .	1 1 0
Will, H. M., M.A., B.Sc. .	117, Victoria Street, Westminster, London, S.W.	1 0 0
Willcock, T. . . .	Dunham Mount, Bowden, Cheshire	1 0 0
Willcox, W. H. & Co. .	36, Southwark Street, London .	1 0 0
†Willett, P. A. . . .	Brighton	..
Williams, E. . . .	Lanusk, Usk	1 0 0
Williams, G. L. . . .	Chavenage, Tetbury . . .	1 1 0
Williams, Major Jestyn .	Llanover Estate, Newport, Mon. .	1 0 0
Williams, J. . . .	Scorrier House, Scorrier, Cornwall .	1 0 0
Williams, J. C., M.P. . .	Werrington Park, Launceston .	1 0 0
Williams, J. G. . . .	Manor Farm, Pendley, Tring .	1 0 0

Name.	Residence.	Subscriptions. £	s.	d.
†Williams, M. Scott . .	Woolland House, Blandford . . .	..		
Williams, P. D. . .	Lanarth, St. Keverne . . .	1	1	0
†Williams, Col. Robert, M.P.	Bridehead, Dorchester . .	..		
Willis, J.	Southwood, Evercreech . .	1	0	0
Willis, J. Deane . .	Bapton Manor, Codford, Wilts .	1	1	0
Wills, A. Stanley . .	21, Royal Crescent, Bath . .	1	0	0
*Wills, Capt. A. S. . .	Thornby Hall, Thornby, Northampton	2	0	0
Wills, Sir Frank . .	Bristol	1	0	0
Wills, G. A. . . .	Burwalls, Leigh Woods, Bristol .	1	0	0
*Wills, W. D. & H. O. .	Bedminster, Bristol . . .	2	0	0
Wills, W.	Marlwood, Thornbury, Glos. . .	1	0	0
Wilmot, S. M. . . .	Albert Road, St. Philips, Bristol .	1	0	0
Winans, W. . . .	Surrenden Park, Pluckley, Kent .	1	0	0
Winter, Major F. J. . .	Canok Lodge, Walton-by-Clevedon, Somerset	1	0	0
†Winterton, Earl, M.P. .	. . . .	..		
Withers, W. R. . .	Lower Court Farm, Long Ashton, Bristol	1	0	0
Wood, W. A., M. & R. Machine Co. . . .	36, Worship Street, London, E. C. .	1	1	0
Woodhouse, G. E. . .	Norden, Blandford . . .	1	0	0
Woodhouse, Lt.-Col. S. H. .	Heatherton, Taunton . . .	1	0	0
Wootton, J. H. . . .	Byford, Hereford . . .	1	0	0
Worrall, W. H. . . .	Clyst St. Mary, Exeter . .	1	0	0
Wright, J. R. . . .	Ades, Chailey, Sussex . . .	1	1	0
Wyatt, A. C. . . .	St. James' Street, St. James' Square, Bath	1	0	0
†Wynford, Lord . .	Warmwell, Dorchester . . .	..		
Yeo Bros., Paull & Co. (Ltd.)	81, Victoria Street, Bristol . .	1	0	0
Yorwerth, T. J. . .	High Street, Cowbridge, Glam. .	1	0	0
Young, E. A. . . .	Mangotsfield, Bristol . . .	1	0	0
Zacharias, J. & Co. . .	Oxford	1	0	0
(28)				
Total . . 913				

INDEX.

END OF VOL. XI.

BATH:
PRINTED BY WILLIAM LEWIS & SON, LTD., 12, NORTH GATE.

BREEDERS' DIRECTORY.

HORSES.

Boddington, Samuel. Breeder of Pedigree Shires. Stallions for service, Mares, Fillies and Colts always on sale. Apply Owner, Hillfield Hall, Solihull, Warwickshire. Telephone: 23, Solihull. Station one mile.

Cobbald, A. H., Eldo House, Bury St. Edmunds, Suffolk. Breeder of Suffolk Horses, Suffolk Sheep, Large Black Pigs. Useful animals for sale at moderate prices.

Graham, Robert, Kaimflat Farm, Kelso. Breeder and owner of high-class Clydesdale Stallions, Colts, and Fillies; most fashionable blood. Large selection. Inspection invited. Station: Kelso, N.E. and N.B. Railways.

Hamilton, Charles R., Fairview Pony Stud, Devon, Pennsylvania, U.S.A. High class Hackney Ponies for breeding and show purposes. Correspondence solicited. Winners at Madison Square Garden, New York, 1916, of Tandem Pair and Championship.

Hunt, Mrs. William, Grey Stud, Findon, Sussex. Registered Grey Brood Mares and Young Stock, both Hackney and Anglo-Arabian, for sale. Grey Hackney Stallions for sale or service, 1917. Station, Worthing. Telegrams: Findon.

Jackson, J. C., Askern. Breeder of Shires. Stallions: Tandridge Tiptop 28851 by King of Tandridge 24351, Champion's Comrade 31298, by Childwick Champion 22215. Thirty other stallions and colts by fashionable sires kept for sale or hire. Fillies for sale. Apply, Faulkner, Smallages, Skyehouse, Snaith, R.S.O., Yorks. Telegrams: Smallages, Stainforth, Doncaster. Stations: Askern, Moss, and Stainforth.

Marden Park Shire Stud, the property of Sir Walpole Greenwell, Bart. Station: Woldingham (within 17 miles of London) on the London, Brighton and South Coast Railway. Stallions for sale or hire. Many good young colts on hand home-bred from the most fashionable strains. For further particulars apply to W. Thompson, Estate Office, Marden Park, Woldingham, Surrey, who will be pleased to show the Stud by appointment.

HORSES—*continued.*

Mond, Robert L., J.P., Combe Bank Shire Stud, near Sevenoaks, breeder of Pedigree Shire Horses. Several good Mares and Fillies for sale. For full particulars apply, L. S. Bull, Estate Office, Combe Bank, near Sevenoaks, Kent.

Mungall, William, Transy, Dunfermline. Most select Stud of fully-predigreed prize Shetland Ponies. Representatives won the Championships of the Royal in 1910, 1911, 1912, 1913 and 1914; of the Highland in 1909, 1910, 1911, 1912, 1913 and 1914; also many other Championships, Specials and First Prizes at leading Shows.

Muntz, Frederick Ernest, Umberslade, Hockley Heath, Warwickshire. Shire Horse Stud Stallions, Mares, Fillies; prize winners. Particulars from Mr. John T. B. Hartley, Estate Office, Umberslade, Hockley Heath, Warwickshire.

Pearson, E. E., Esq., Brickendon Shire Stud. A number of Stallions kept for service, or to let on reasonable terms, and Stallions, Mares and Fillies of the best blood, and in growing condition, always on sale. Prize-winners. The Stud Farm can be seen by appointment. For terms, nominations, and full particulars, apply, Estate Office, Brickendonbury, Hertford, Herts. Telegrams: Stud, Avenue, Hertford.

Robinson, Ernest W., Brookleigh Stud, Liscombe, Leighton Buzzard. The Tower, Family 8, G.S.B. Vol. 21, p. 626; Bobrikoff, Family 8, Vol. 22, p. 823; Red Hand, Family 19, G.S.B. Vol. 22, p. 20. Irish-bred 1, 2, 3 and 4-year-olds, Brood Mares, made and unmade Hunters for sale. For particulars, apply as above.

Rycroft, W. W., Drake Hill Stud, Bingley, Yorks. Stud Horses: Hopwood King 11804, Reserve Supreme Champion (London, 1916), Senior Champion (London, 1915), Reserve Senior Champion (London, 1914), Junior Champion (London, 1913); Bingley Toreador 12312, 1st

HORSES—*continued.*

(London, 1915), Junior Champion (London, 1914), and Reserve for best Stallion shown; Admiral Cliquot 11667, 1st (London, 1914), Junior Reserve Champion, 1913; Heaton Performer 11063, 1st (London, 1910). Champion Mares and young stock a speciality.

FLEMING, J. WILLIS, Esq., STONEHAM PARK STUD, EASTLEIGH, HANTS. Thoroughbred Stallions: (1) "Radames by Radium. out of Galicia (dam of Bayards and Lemberg); (2) "Egret" by Gallinule, out of Lady Elect, by Beldemonis; (3) "Vectis" by Vernham, out of Fruit Girl, by Meddler; and (4) "Guiding Star," by Royal Gard, out of Gatien Star, by Roscius. Apply as above.

CATTLE.

Aberdeen-Angus.

BRIDGES, J. H. This old-established herd of the best families can be seen at the Home Farm, Langshott, and catalogue obtained on application to J. Hill, Langshott, Horley, Surrey.

COOPER, SIR GEORGE, HURSLEY PARK, WINCHESTER. All fashionable strains: Prides, Ericas, Miss Burgess. Stock Bulls: Evolsurus, sire of many winners; Black for Ever of Ballindalloch. For catalogue, apply Estate Office, Hursley, Winchester.

CRIDLAN, J. J., MAISEMORE PARK, GLOUCESTER. Stock Bull: Everard II. of Maismore 31888; awarded ten First Prizes, three Gold and two Silver Championship Medals at R.A.S.E., Highland, etc. The herd has won 209 First, 132 Second Prizes, 26 Gold, 40 Silver Champion Medals, Smithfield, Championships 1910, 1914, 1916, final winner of King Edward VII.'s £105 Challenge Cup, 1914; awarded Fat Stock Championships, Smithfield, 1910, Norwich, 1907, 1910, 1911, 1912, 1915, Ipswich, 1911, 1912, 1914, York, 1912.

HOYLES, GEORGE, SKIDBY MANOR, HULL. Polled Angus Cattle: Queen Mother, Erica, and Prides. Bulls and Heifers for sale. Inspection invited. Several prize-winners.

CATTLE—*continued.*

HURSLEY PARK ABERDEEN-ANGUS HERD, the property of Sir George Cooper, Bart. Erica Pride of Aberdeen, and other noted families. Prices won, 64 firsts, 37 seconds, 14 gold, 8 silver medals, and many champion prizes. Apply, J. E. Thorald, Estate Office, Hursley, Park, Winchester.

McAINSH, JOHN, CONGASH, GRANTOWN-ON-SPEY, N.B. Owner of the oldest Herd of Aberdeen-Angus Cattle in Strathspey. Bulls, Cows, and Heifers Always on sale. Inquiries invited.

THEAKSTON ABERDEEN-ANGUS HERD. Established 1883. 150 head Registered Cattle. Several grand Yearling Bulls and Heifers for sale. Ballindalloch sires.—Owner, J. McINTYRE, Theakston, Bedale, Yorkshire.

TUBBERDALY HERD. Jilts, Ericas, Prides, Lady Idas, Miss Burgess, Marys of Shanvaghey. Young animals on sale. E. J. Beaumont Nesbitt, Tubberdaly, Edenderry.

Ayrshire.

WALLACE, JAMES, AUCHENBAINZIE, THORNHILL, DUMFRIESSHIRE, SCOTLAND. Pedigree prize-winning Ayrshire Cattle. Hardy, healthy, good milkers. Young stock by milk record sires always on hand.

British Holsteins.

DEBENHAM, E. R. AND A., BLADEN DAIRY FARMS, BRIANTSPUDDLE, DORCHESTER. Pedigree herd British Holsteins. 1st and 2nd prize-winners Royal 1911, 1914. Stock bull 1915 the imported bull Robert, bred by F. Wassenaav, Leeuwarden, descended from cows with high butter-fat percentages.

JARMAN, I. B. AND H. L., BULKELEY HALL, MALPAS, CHESHIRE. Pedigree British Holstein-Friesian Calves always for sale by Mietje's Ceres, imported bull with highest milk ancestry, and took second prize this year's R.A.S.E. Manchester, only time shown. Inspection invited.

BREEDERS' DIRECTORY.

CATTLE—*continued.*

Devons.

HUXTABLE, JOHN L., OVERTON, BISHOP'S TAWTON, BARNSTAPLE. Devon Cattle and Devon Long-woolled Sheep. Winner of Champion Prize for Bulls at the Association Show and sale at Exeter, 1912. Twice Champion for Devon Long-woolled Sheep at Devon County Shows for all Breeds, and numerous other prizes.

Jerseys and Guernseys.

PEDIGREE HERD PRIZE-WINNING GUERNSEYS, bred from Island strains. Bulls and Heifers for sale. Mrs. R. C. Bainbridge, Elfordleigh, Plympton, S. Devon.

FOWLER, P. T., LA PASTORELLE, ICART, GUERNSEY. Pedigree Guernseys and Jerseys, carefully selected from prize stock of the Islands. Please state requirements. Shipper to all parts. Established 1811.

FOWLER AND DE LA PERRELLE, PORTERS LANE, SOUTHAMPTON, the largest importers of Jerseys and Guernseys. Cows and Heifers calving all the year round. Bulls of the best strains. No objection tuberculin test. Moderate prices. Shipping attended to. Horn Trainers and Self-piercing Bull Rings. Telegrams: "Importers, Southampton."

JEROME, MRS., BILTON HALL, YORK. Pedigree Jersey Cows and Heifers; prize-winners, for sale.

Kerries and Dexters.

PALMER, CAPTAIN, R.E.—Pedigree Kerries. Bulls and Heifers, all ages. Address: The Foreman, Oaklands Park, Newdigate, Surrey. Stations: Holmwood, Horley, or Faygate, L.B. and S.C. Telegrams: Palmer, Newdigate. Telephone: No. 5, Rusper.

BROWN, STEPHEN J., ARD CAEIN, NAAS, CO. KILDARE. Pedigree Kerries. Prizes at leading Shows, including Royal of England, Dublin, and Royal Ulster.

Lincoln Red.

ROBINSON & SON, ANDERBY BANK, ALFORD, LINCS. Lincoln Red Shorthorn Bulls for sale, descended from best Herds. Beef and milking qualities combined. Inspection invited. Station: Mumby Road, G.N.R.

CATTLE—*continued.*

Longhorns.

EASTWELL PARK HERD OF LONGHORNS, the property of Lord Gerard, winner of first prize Royal Show for Bulls, 1913, 1914, and 1916; 1st and 2nd, Cows, 1914. Bulls and Cows for sale. Apply, Henry Parsons, Estate Office, Eastwell Park, Ashford, Kent.

Shorthorn.

BRITTEN, ARTHUR, GREAT BILLING, NORTHAMPTON. Typical dual-purpose herd; robust constitution. Milk records kept. Bulls in service: Edgcote Trumpeter, Vol. 62, Collynie Monarch 94686.

CHIVERS & SONS, LTD., HISTON, CAMBS. Long Pedigree Dairy Shorthorns, best milking families, daily milk records. Young stock for sale.

COMBE BANK HERD OF PEDIGREE DAIRY SHORTHORNS, the property of Robert L. Mond, Esq., J.P., Combe Bank, Sundridge, near Sevenoaks. Milk records strictly kept. Young Bulls and Heifers always for sale from the oldest and best strains. Send for booklet to L. S. Bull, Estate Office, Combe Bank, Sundridge, near Sevenoaks.

COLLEGE OF AGRICULTURE, HOLMES CHAPEL, CHESHIRE. Pure-bred Dairy Shorthorns. Milking records kept. Bull Calves and Heifers for sale. Station, Holmes Chapel, L. & N.W., ½ mile. For particulars apply to the Principal.

DESBOROUGH, LORD, K.C.V.O., PANSHANGER, HERTFORD. Pedigree Shorthorns. Young Bulls and Heifers for sale. Stock Bulls used 1916: Collynie Regal King 114769, and Proud Star 117142, and Nonpareil Champion 112667. Apply G. J. Turner, Estate Office, Cole Green, Hertford.

FORTESCUE, THE MISSES E. B. I. AND J. T. I., MONDYNES, FORDOUN, KINCARDINESHIRE. Pedigree Shorthorns Cruickshank blood. Station: Drumlithie.

CATTLE—*continued.*

Hean Castle Herd (the property of Lord Merthyr, Hean Castle, Saundersfoot, Pembrokeshire). Pedigree Shorthorns of the Augusta, Brawith Bud, Broadhooks, Clipper, Lavender, Missie, Princess Royal, and Secret Families. Stock Bulls: Collynie Chancellor (119543), red; Royal Roman (122652), red.

Hobbs, Robert W., & Sons, Kelmscott, Lechlade, Glos. Herd of 500 Dairy Shorthorns. Milk records kept. Many Cups. Medals, Champion and other prizes won for Inspection, Milking, and Butter Tests, including the Fifty Guinea Group Challenge Cup at the Royal Show for the last three years, and the Gold Medal, Shorthorn Society's Prize, "Spencer" and "Shirley" Challenge Cups at the London Dairy Show. Bulls and Bull Calves always on sale. Four cross-Bull Calves at moderate prices, suitable for non-pedigree dairy herds a speciality. All Cows in milk and the Stock Bulls have passed the Tuberculin Test.

Law, Messrs., Mains of Sanquhar, Forres. Select Herd Scotch Shorthorns. Stock bulls: Collynie Grand Knight, Sanquhar Grand Knight, Newton Count. Young stock for sale. Herd always on view by appointment. Telegrams: Law, Sanquhar, Forres.

Lydney Park Herd of Pedigree Shorthorns, the property of Captain Charles Bathurst, M.P. Young Bulls and Heifers of Bates and Scotch strains (all dark Reds). Apply J. Lauder, Estate Office, Lydney Park, Glos.

Marden Park Shorthorn Herd, the property of Sir Walpole Greenwell, Bart. Station: Woldingham (within 17 miles of London on the London, Brighton and South Coast Railway). This splendid Herd of Shorthorns, with great adaptability for producing flesh, can be viewed any time by appointment. The Stock Bulls are Marden Dane (106128) and Pride of Sittyton (100005). The Herd has been very successful in the showyard. For further particulars apply, W. Thompson, Estate Office, Marden Park, Surrey.

Pellipar Herd of Shorthorns. Lieut.-Col. R. J. L. Ogilby, Pellipar, Dungiven, Co. Londonderry. Carefully bred animals of the following families:—Augusta, Brawith Bud, Butterfly, Fragrance, Clipper, Goldie Lovely, Luxury, Nonpareil, and Pye (Garne's). Stock Bulls: Count Crystal 108276, Broadsword 119237, and Edgcote Regalia 125396. Apply Estate Office.

Rickerscote Herd of Pedigree Dairy Shorthorns, the property of Messrs. C. and E. Stephenson. Milk records taken daily. Tuberculin test periodically. Bulls, Heifers, Calves, etc., always for sale. Apply, E. Harris Stephenson, Burton House, near Stafford.

Rothwell, R. R., Jun., Much Hoole, Preston. Pedigree Dairy Shorthorns, Heavy Milking Cattle with substance. Inspected records kept. Apply to D. W. Collyer, Estate Office, Miller Arcade, Preston.

Rowlands, Joseph, Evesbatch Court, Bishop's Frome, near Worcester. Bulls and Heifers for sale, from royal prize-winning stocks.

Sanders, J. W., Gilmorton, Lutterworth. Dairy Shorthorns, combining milk with flesh. Winner at London Dairy Show, 1908, and Shorthorn Society's Prizes, Royal Dublin, 1909 and 1910, Oxford, Royal Counties, and Royal 1910; Oxford, Leicester, Northampton, and Warwick 1912 to 1916. Average milk yield of herd for last year, 7,892lb. Young Bulls for sale.

Silcock, R. & Sons, Poulton le Fylde, Lancashire. Herd of Pedigree Dairy Shorthorns. Milk record kept (inspected by the Dairy Shorthorn Association). Young Bulls for sale from deep-milking cows.

Stapleford Park Herd. Lincoln Red Shorthorns. A few young Bulls and Heifers from good milkers for sale. Apply, C. S. Harvey, Wymondham, Oakham.

Thornton, Frank H., Kingsthorpe Hall, Northampton. Pedigree Dairy Shorthorns. Winners of many prizes, including first prize Milking

CATTLE—*continued.*

Trials Royal Show, 1911 and first prize Heifers' Milking Class Dairy Show, and Breeders' Silver Medal, 1915. Daily milk records. Butter-fat tests. Rich milking Cows a speciality. Herd tested annually by J. B. Manuel, V.S.

CATTLEY, W. E. Breeder of South Devon Cattle; also Pedigree Large Black Pigs of the purest strains. Inspection invited. Apply J. E. Hunt, Clowance Barton, Praze, Cornwall. Telegrams and Station: Praze.

SHEEP.

Herdwick.

STANLEY-DODGSON, S. D., TARNBANK, COCKERMOUTH, CUMBERLAND. Herdwicks, the hardiest British mountain breed of sheep. Winners at Royal Shows for many years.

Hampshire Downs.

JUDD, EDWARD THOMAS, COCUM, SUTTON SCOTNEY, HANTS. Highly-bred Flock of 1,000 registered Hampshire Down Ewes. Noted for great size and early maturity. Annual Sales at Weyhill, Marlborough, Peterborough, Partney, and Stamford Fairs.

Kent or Romney Marsh.

COMBE BANK FLOCK OF ROMNEY MARSH SHEEP. Mr. Mond having purchased a complete flock from Mr. Neame, of Macknade fame, buyers of this strain will always have an opportunity of purchasing the pure Macknade blood. For particulars, apply, L. S. Bull, Estate Office, Combe Bank, Sundridge, near Sevenoaks.

CLARK, WILLIAM F., NORTH COURT, EASTLING, NEAR FAVERSHAM, KENT. Breeder of Kent Sheep. "Eastling Flock."

FINN, ARTHUR, WESTBROKE, LYDD, ROMNEY MARSH, KENT. This flock, established for more than 140 years, maintains the highest reputation. Gained first and second prizes in Flock Competitions, 1912–13. Inspection invited of 2,000 registered sheep grazing in Romney Marsh. Selections always for sale.

SHEEP—*continued.*

Lincoln Long-Wools.

BROCKLEBANK, JOSEPH, CARLTON-LE-MOORLAND, NEWARK. Pure-bred Lincoln Long-wool Sheep, Flock 10. Large numbers are sold for export every year. Given satisfaction both at home and abroad. Inspection invited. Telegrams: Bassingham. Station: Navenby.

HOYLES, GEORGE, SKIBBY MANOR, NEAR HULL. Pure Lincoln Long-wool Sheep. True type, sound constitutions, lustrous long-wool. Give satisfaction at home and abroad. Sires used last year: Riby Gordon 13053, Riby Pointon Prince 10926, Skidby Laughton 4th 12630, Barff Mere Skidby 12175, etc. Foreign and home buyers invited to inspect flock. Rams and Ewes exported to Buenos Ayres, Mexico, Russia and Africa.

STAPLEFORD PARK HERD OF LINCOLN RED SHORTHORNS. A few young Bulls and Heifers from carefully tested milking strains. L. S. Harvey, Wymondham, Oakham.

Oxford Downs.

AKERS & CO., HENRY, BLACK BOURTON, CLANFIELD, OXON. Pedigree Registered Oxford Downs. Ram and Ewe Lambs on sale. Inspection invited. Annual Sales: Oxford Ram Fair, Cirencester, Shrewsbury, Kidderminster, Northampton, Nottingham and Leicester.

HOBBS, ROBERT W. & SONS, KELMSCOTT, LECHLADE, GLOS. Flock of 1,000 registered Oxford Downs. Numerous prizes won at the principal shows. Rams, Ram Lambs and Ewes always on sale. Rams sold annually at Oxford, Cirencester, Kelso, Northampton, and other fairs.

Southdowns.

MARDEN PARK SOUTHDOWNS, the property of Sir Walpole Greenwell, Bart. Station: Woldingham (within 17 miles of London, on the London, Brighton, and South Coast Railway). Registered Flock Book No. 77. A number of pure-bred Rams and Ewe Tegs by pedigree sires of the best blood always for sale. Numerous prizes taken in the showyard. For further particulars, apply, W. Thompson, Estate Office, Marden Park, Surrey.

BREEDERS' DIRECTORY.

SHEEP—*continued*.

Ryeland.

HOBBS, C. H., OLDPORT, OSWESTRY Ryeland Flock, No. 11. Ewes and Rams for sale.

RYELAND SHEEP. Pedigree and prize-winners at various shows, Royal Worcester, Abergavenny, and others. Rams and young stock always on sale. Inspection invited. Apply Manager, Clytha Park, Abergavenny.

PIGS.

Berkshires.

WHITLEY HERD OF PEDIGREE BERKSHIRES, property of Reading Corporation. Over 300 head, producing prize-winners at leading shows. Unrelated strains. Prices moderate. Apply, Mr. T. Chettle, Whitley Reading.

Large Blacks.

CURRIE, A. C., SAPPERTON, CIRENCESTER., GLOS. Large Black Pigs, registered, healthy, farm-bred on top of Cotswold Hills, from best stock. Gilts and Boars for sale.

JOHN PARK. MANOR FARM. WILLINGHAM, GAINSBOROUGH. Large Blacks, Boars and Gilts generally for sale. Bred from best Sudbourne and Hooley blood.

PEARCE, E. W., THE CHURCH FARM, WHITTINGTON, LICHFIELD. Large Black Pigs, Boars and Gilts, descended from Champion Royal winners, for sale. Prices reasonable. Stations: Lichfield City and Trent Valley, two miles.

Large White.

EDWARDS, ARTHUR B., BUSHES FARM, MAGDALEN LAVER, ONGAR, ESSEX. Pedigree Large White Boars and Gilts for sale. Apply A. B. Edwards, Brewery House, Harlow, Essex.

CHIVERS & SONS, LTD., HISTON, CAMBS. Pedigree Large White Pigs. Fine quality, good type, best strains. Young stock for sale.

DENNY, E. H. M., STAPLEFIELD PLACE, STAPLEFIELD, SUSSEX. Large White Yorkshire Pedigree Pigs. Station Hayward's Heath. Telegrams: Handcross.

PIGS—*continued*.

GREENALL, SIR GILBERT, BART., WALTON HALL, WARRINGTON. Walton and Worsley herd Pedigree Large White Pigs. Selections for sale at most moderate prices. In the eight Classes for Large White Pigs at the Royal Show, Manchester, 1916, the herd obtained five Firsts, both Championships and Reserves for same, with home-bred exhibits. In the six Classes entered at the Royal Show, Nottingham, 1915, the herd obtained 16 awards, including Champion and Reserve Champion. At the Royal Lancashire Show, 1915, in five Classes, 11 awards and Championships. At Birmingham Fat Stock Show, Championship over all breeds, and at Smithfield Club Show, London, the Breed Cup and Reserve for best pen in the show. Inspection and enquiries cordially invited. Apply to Richmond Daybell, Manager, Rowswood Farm, Higher Walton, Warrington, or to G. Lousada, The Office, Bridge House, Higher Walton, Warrington.

HUGHES, ALFRED, PACKWOOD GRANGE, KNOWLE, NEAR BIRMINGHAM. Select herd of Pedigree Large White Yorkshires, bred from prize-winners. Pigs of various ages for sale at moderate prices.

KIRBY BEDON HERD of Pedigree Large White Pigs of prize-winning strain. Grand young Boars and Gilts for sale at moderate prices. Hardy constitution; size and bone a speciality. For particulars apply W. Mitchell, The Vale, Kirby Bedon, near Norwich. Two miles from Trowse Station, G.E.R.

ROTHWELL, R. R., JUN., FULWOOD HALL FARM, PRESTON. Herd of 200 Pedigree Large White Pigs. Prizes have been won at Principal Shows. Apply to D. W. Collyer, Estate Office, Miller Arcade, Preston.

Middle Whites.

BOOKHAM HERD PURE PEDIGREE MIDDLE WHITE PIGS, the property of Victor Hayward, Bookham Grove, Surrey. Large selection of Young Stock. Boars and Sows prolific strain and early maturity. Winners of numerous prizes. Inspection invited.

BREEDERS' DIRECTORY.

PIGS—*continued.*

Chivers, John, Histon, Cambridge. Select herd of Pedigree Middle White Pigs. Double Champion winners, Royal, 1916. Promising young stock for sale. Inspection invited.

Jerome, Mrs., Bilton Hall, York. Pedigree Middle White Pigs, prize-winners. Boars and Gilts for sale.

Salvation Army Colony Pedigree Herd of Middle Whites. The herd is bred from Pigs of the best strains in the country. Careful selection made for buyers unable to make personal choice. Apply, The Governor, Land nad Industrial Colony, Hadleigh, Essex.

Stapleford Park Herd of Middle White Pigs. A few Gilts and Boars for sale. Apply, C. S. Harvey, Wymondham, Oakham.

Sundon Herd of Large and Middle White Pedigree Pigs, the property of Albert Laird, The Manor, Sundon, Dunstable, Beds. Large selection grand young stock and typical specimens both breeds for sale. Winners of champions and numerous prizes.

Wharfedale Herd of Pedigree Middle White Pigs. Championship at Royal Shows, 1908, 1909, 1910, 1913, 1914, 1915; and again successful at the Royal Show, Manchester, 1916. Eight prizes and reserve championships; first and second for pens of Gilts; first and second for young Boars, all home-bred. Apply, Leopold C. Paget, Middlethorpe Hall, York.

Tamworths.

A Few Young Boars and Gilts, bred from best blood, always on sale. Moderate prices. Stock on grass the year round. W. Ellaway Smith, Loxley Estate Office, Uttoxeter. Telegraphic address: "Loxley, Uttoxeter."

De Hamel, Egbert, Middleton Hall, Tamworth. Pedigree Red Tamworth Pigs, Boars, Gilts, and In-pig Sows, bred from prize winners at Royal and County Shows. Prices moderate. Full particulars on application.

POULTRY.

Currie, A. C., Sapperton, Cirencester, Glos. White Wyandotte and White Orpington Cockerels. Eggs for sitting, best utility strains. Healthy, farm-bred, altitude 600 feet on Cotswold Hills.

Godwin, William Henry, Lugwardine, Hereford, England, the introducer of "Rhode Islanders" to England (also "Salmon Faverolles") sends out Eggs and Birds. Hardy, rapid growers, rentpayers and money-makers. Bred to lay, win, and weigh. The two utility great breeds of the future.

Harper, Gage, Mason's Bridge, Raydon, Ipswich. Breeder, Exhibitor and Exporter Mammoth Bronze Turkeys. Cock Turkeys always on sale. Price lists and testimonials on application. Inspection invited. Telegrams: Harper, Hadleigh, Suffolk.

Major, Arthur. Breeder and Exhibitor thirty years. Champion Dark and Silver Grey Dorkings, "England's best fowl." Prizes at all shows, and exported all over the world Prices moderate. Eggs 1s. each. Arthur C. Major, Ditton, Langley, Bucks.

Popham, H. L., Pensford, Somerset. Good Light Brahmas at moderate prices. Cups and prizes won at Crystal Palace, Dairy, Birmingham, etc.

Sussex Poultry. The property of Messrs. C. and E. Stephenson. Red Sussex, Light Sussex, and Speckled Sussex. 1st Royal Show, Manchester, 1916, and many other prizes won. Cockerels and Pullets always for sale. Eggs for sitting in season. E. Harris Stephenson, Burton House, near Stafford.

The Combe Bank Poultry Yards, the property of Robert L. Mond, Esq., J.P., Combe Bank, Sundridge, near Sevenoaks. The Buff, White, Black, and Blue Orpingtons from these yards obtained the premier honours at the leading shows in 1913. Birds from these strains exported to all parts of the world. White Leghorns (Padman's strain), Speckled